Wenck Associates, Inc.

May 18, 1990

Consulting Engineers
(612) 479-4200

Mr. Alan Sorsher
Department of Health Services
Toxic Substances Control Division III
1405 No. San Fernando Blvd., Suite 300
Burbank, CA 91504

Re: Hydrogeological Assessment
317 & 342 Areas
Bermite Division, Whittaker Corp.

Dear Mr. Sorsher:

Please find attached the Hydrogeological Assessment for the 317 and 342 Areas at the Bermite Division, Whittaker Corporation. This report is submitted for your review and approval.

If you have any questions regarding the report please contact Mr. Norman Wenck or me at (612) 479-4200.

Sincerely,

WENCK ASSOCIATES, INC.

Christopher F. Thompson, P.E.

CFT/rlb

cc: Ed Muller, Whittaker
Al Simmons
Glen Abdun Nur, Bermite
Alan Sorsher, DHS
Jan Palumbo, EPA - Region IX
Jim Ross, RWQCB

1800 Pioneer Creek Dr.
Maple Plain, MN 55359
FAX - (612) 479-4242

HYDROGEOLOGICAL ASSESSMENT OF THE 317 AND 342 AREAS

Prepared for:

BERMITE DIVISION
Whittaker Corporation
22116 West Soledad Canyon Road
Saugus, California 91350

Prepared by:

WENCK ASSOCIATES, INC.
1800 Pioneer Creek Drive
Maple Plain, Minnesota 55359
(612) 479-4200

MAY 1990

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of California

5-17-90

Norman C. Wenck, P.E. Registration Number 41317

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

I. INTRODUCTION

A. Purpose of Hydrogeological Assessment

The purpose of this hydrogeological assessment is to compile available technical information regarding the soils and groundwater at the 317 and 342 Areas of the Bermite facility to assess the adequacy of the existing groundwater monitoring system at these two areas. This hydrogeological assessment has been prepared in fulfillment of the groundwater monitoring requirements of 40 CFR 265.90.

B. Scope of the Hydrogeological Assessment

This Hydrogeological Assessment has been prepared using the information gained during the installation and completion of six existing groundwater monitoring wells located at the 317 and 342 Areas, geologic data obtained during surface soil excavation and remediation activities at the 317 Area, and geologic data obtained during surface soil investigations performed under the approved RCRA Closure plan for the Bermite facility. In addition, existing technical reports and data regarding the geology and hydrogeology in the region of the Bermite facility have also been reviewed and are used in this assessment.

This Hydrogeological Assessment consists of reviewing the available technical reports regarding the climatological, hydrogeological and geological conditions within the region and specifically focusing in on the conditions at and very near the Bermite facility. There are two previous region-wide hydrogeological investigations that were available for this report. The first of these, USGS (1972), was performed approximately 20 years ago. The second investigation, Slade (1988), was performed as part of a water supply study completed for the five water agencies in the Santa Clara Valley in which the Bermite facility is located. The Slade (1988) report is similar to the USGS (1972) report in that a number of deep municipal water wells were used for determination of the depth of the major aquifer in the region and the aquifer parameters of transmissivity and storage coefficient.

The Bermite Division of Whittaker Corporation installed six groundwater monitoring wells at the 317 and 342 Areas starting in the summer and fall of 1987. Documentation reports of the construction of these six wells have been previously submitted to the Environmental Protection Agency (EPA) and Department of Health Services (DHS). A number of exploratory and producing oil wells have been drilled both at the Bermite facility and in the region. A number of these wells were used in the description of the geology and hydrogeology both by the USGS (1972) and by Slade (1988). These oil wells have also been used in other extensive descriptions of the geology in the region and copies of available documents regarding the geology of the region were obtained for this assessment.

This assessment first describes the Bermite facility and specifically the activities which occurred at the 317 and 342 Areas. In addition, a summary of past geologic and hydrogeologic investigations at the facility is given. Regional and local climatological and surface land use is then described which provides a background on the influences to the hydrogeology at the Bermite facility. The regional and local geology is then described in detail. From this geological review the hydrogeology in the region is described. After a review of the existing groundwater monitoring system, a summary and recommendations are presented. The tables and figures of the report are either bound herein or are included in figure pockets. The appendices of the report contain regional photographs and documentation from the well and boring construction activities at the 317 and 342 Areas. A summary of references is included at the end of the text.

C. History of Facility Use

1. Bermite Facility

The Bermite Facility is a former ordinance manufacturing plant located on approximately 950 acres in the City of Saugus, California. The address of the facility is 22116 West Soledad Canyon Road, Saugus, California 91350. The Bermite facility historically manufactured military ordinance, including rocket propellant, flare mixes and BP-1 powder.

A vicinity map is included as Figure 1 which shows that the region in which the Bermite facility is located north of the City of Los Angeles, California. This map shows the Bermite facility to be located on the northern fringe of the greater Los Angeles metropolitan area, inland from the Pacific coast approximately 50 miles. A regional topographic site map is included as Figure 2. The region extends from the City of San Fernando to the southeast of the Bermite facility to Castaic Valley to the northwest, a distance of approximately 15 miles. Aerial photographs of the region including the Bermite facility are included as Appendix A. The Bermite facility boundaries are shown on the topographic map of Figure 3.

The Bermite Division of Whittaker Corporation, originally the Bermite Powder Company, began operations about 1905. The Bermite Powder Company was purchased by the Whittaker Corporation in 1968. The facility was closed in April 1987. At the time of closure, the Bermite facility had 14 Resource Conservation and Recovery Act (RCRA) units with permits for interim operation. These units were used for the storage and treatment of potentially explosive wastes or for the storage of organic solvents, prior to off-site disposal.

An approved RCRA Closure Plan was received by Bermite in December 1987. Prior to and after December 1987, activities took place, under the direction of the DHS and EPA for closure of the RCRA units. Nine of the units are presently formally closed with closure for three additional units expected. The 317 and 342 Areas are not yet formally closed.

2. 317 and 342 Areas

a. Surface Impoundment History

The 317 Area RCRA unit was a former Hypalon-lined surface impoundment that was used to collect and store waste organic solvents prior to manifesting for off-site treatment and/or disposal. These solvents were used in a degreasing operation in building No. 317. All wastes were removed from this unit and were shipped to an off-site class 1 facility during late 1983. The impoundment was closed at that time and no longer exists. The liner was inspected at the time of closure and did not have any rips or tears. Sampling of the soils beneath the impoundment in 1983 did not detect soil contamination by organic solvents. Figure 4 shows the former location of the 317 surface impoundment.

The 342 Area RCRA unit was a Hypalon-lined surface impoundment that was used to collect and store stabilized phosphorous prior to manifesting for off-site treatment and disposal. The wastes were removed from this unit and were shipped to an off-site facility during late 1983. The unit was closed at that time and no longer exists. Inspection of the liner upon removal did not detect any rips or tears. Soil sampling at that time did not detect soil contamination by phosphorous. Figure

4 shows the former location of the 342 surface impoundment. The 342 Area is located southwest of the 317 Area approximately 1000 feet.

b. Nature of Organic Compounds in 317 Former Surface Impoundment

The primary organic solvent which was stored in the 317 surface impoundment and the compound that has been detected in the greatest concentration in both the soils and groundwater at the 317 Area is trichloroethylene (TCE). The TCE which was purchased by Bermite for the degreasing operations at building 317 was, most likely, not 100% pure TCE. Impurities are known to exist in commercial grade solvents. During subsequent soils investigations at the 317 Area, as described below, 18 separate volatile organic compounds (VOC) were detected in the soils. The specific physical and chemical qualities of these organic solvents were described previously by Wenck (September 1989 C). A compilation of the 18 VOC's and known physical, chemical and fate constants for these compounds are included in the attached Table 1.

TCE has been detected in the groundwater at the 317 Area. After two quarters of non-detection of volatile organic compounds, TCE was detected in one well (well MW-4) located at the 317 Area. As will be discussed below, the TCE is now at a concentration that is just above the detection limit. The nature of this volatile organic compound is as follows:

> TCE has a relatively high vapor pressure and Henry's Law constant (see Table 1) and would be expected to rapidly volatilize into the atmosphere under normal conditions of pressure and temperature. The soil/water partitioning coefficient for TCE is representative of a compound which is considered highly mobile in the soil environment and is not strongly adsorbed

to soils. TCE is considered to be hydrophobic, (lacks affinity for the aqueous phase). However, the solubility of TCE is approximately 1100 mg/l. TCE has a low bioconcentration potential and therefore is not readily bioaccumulated by plants and organisms. In addition, the biodegradation of TCE is considered to occur at a relatively fast rate. The liquid density of TCE is 1.41 kg/l and, therefore, is more dense than water.

3. Past Geologic Investigations at the 317 and 342 Areas

In June and July 1987 fifteen soil borings were advanced at the 317 and 342 Areas . The total depth of the borings at the 317 Area reached approximately 301 feet, while the total depth at the 342 Area reached approximately 70 feet. The report of these borings and the boring logs from the borings are included as Appendix B. Low levels of VOC were detected in some of the borings at depths to 120 feet. The borings were initially advanced with hollow stem auger but this method of drilling proved inadequate for the large cobbles and boulders encountered. Rotary air drilling with foam additives was used for the majority of these borings.

Subsequent to these initial soil borings and after preparation of a work plan for soil investigations as required by the approved RCRA Closure Plan, additional near surface soil borings were performed at both the 317 and 342 Areas. Thirteen borings were performed and the total depth of each boring was approximately 20 feet. The purpose of these verification borings was to determine the presence or absence of a number of metal compounds in the soils at both of these former RCRA units, and for the determination of the presence or absence of volatile organic compounds at the 317 Area. The results of these investigation were reported by Wenck (March 1988 B). The metals analyzed were not detected above background soil concentrations. Low levels of some VOC were detected at the 317 Area.

Additional geological investigations have been undertaken at the 317 Area as a result of the DHS and EPA approved excavation of VOC contaminated soils. Soils at the 317 Area were excavated from the former ground surface to a depth of approximately 50 feet. At this depth, a number of subsurface vapor probe nests have been installed to a depth of 120 feet or approximately 170 feet below the former surface impoundment. One vapor probe nest was installed to a depth of approximately 220 feet from the bottom of the excavation which is a total depth of approximately 270 feet below the former surface impoundment. The results of the excavation and vapor probe nest installation activities have been reported in a number of documents submitted to the DHS and EPA. The results of the vapor probes determined that VOCs had migrated to a depth at least 170 feet below the former surface impoundment at the 317 Area. The results of the above referenced investigations are used below in the description of the geology at both the 317 and 342 Areas.

4. Past Geologic and Hydrogeologic Assessments at the Bermite Facility

The first geologic and hydrogeologic assessment performed for the Bermite Facility was performed in February 1986 and was made part of the Part B Application submitted in fulfillment of the permitting requirements for the RCRA units at the facility. This assessment was performed by Meredith/Boli and Associates in conjunction with Mr. Robert T. Bean, Consulting Geologist. At that time, groundwater occurrence at the Bermite facility was consider to be "irregular due to variations in infiltration capacity and permeability of the sedimentary materials, variations in dip, and faulting." Specific information regarding geology at the 317 and 342 Areas was not available at that time.

A second hydrogeological assessment was performed by Robert Bean in conjunction with the subsurface borings preformed in July 1987, which is contained in Appendix B. As a result of those borings, the soils beneath the 317 Area had been logged to a depth of approximately 300 feet and it was known that the majority of the lithology to that depth consisted of sands and gravels with some minor amounts of clay. The method of drilling which was required to reach the depth of 300 feet, rotary air with foam addition, did not allow logging or characterization to the lithology of the 300 foot depth. In Mr. Bean's assessment it was determined that no groundwater was encountered to the 300 foot depth at the 317 Area and to the 60 foot depth at the 342 Area.

A third geological and hydrogeological evaluation was made of the 317 and 342 Areas as a result of the installation of groundwater monitoring wells MW-1, MW-2 and MW-3 in May 1988. This assessment was essentially an update of Robert Bean's earlier assessment in 1987 and was modified by the results obtained from the installation of the three monitoring wells. The conclusions of the assessment are contained in Wenck (May 1988). At this time it was determined that the first encountered groundwater was under confined conditions and occurred at depths of 460 to 675 feet, (elevation 860 to 960 feet National Geodetic Vertical Datum (NGVD)). The horizontal groundwater flow direction was determined to be in the west-northwest direction.

II. BACKGROUND

A. Topography

1. Regional

The Bermite facility is located in northwestern Los Angeles County approximately one mile northeast of the City of Newhall, California. The topography in this region consists of low-lying mountains divided by the Santa Clara River and its major tributaries. The Santa Clara River flows west to the Pacific ocean approximately 50 miles from the Bermite facility. Elevations along the Santa Clara River Valley range up to about 1400 feet while elevations for the mountains to the north and south of the river valley range from about 1500 to 4000 feet.

2. Local

The Bermite facility consists of approximately 950 acres located between the Santa Clara River Valley on the north and the Placerita Canyon on the south (see Figure 3). Specifically, the two areas of concern for this report, the 317 and 342 Areas on the Bermite facility, are located on roughly 50 acres in the southeast portion of the Bermite property (see Figure 4).

The ground elevations across the above 50 acre site range from between 1530 to 1560 feet at the 317 Area to the east and drop towards the middle of the site to approximately 1500 feet. To the west there is a pronounced drop in elevation towards the 342 Area in the southwest corner of the site. The elevations for the 342 Area range from approximately 1420 to 1445 feet.

Vegetation is sparse with accumulations of low lying grasses, sage and cactus in the valleys and outwash bottoms. Surface drainage across the site is generally from northeast to southwest or from the 317 Area to the 342 Area. Drainage from the 342 Area continues to the southwest and eventually reaches Placerita Canyon.

B. Land Use

Historically, this region was generally rural with agriculture and oil field activities being the major land uses. Some of the original oil wells date back to the late 1800's. Throughout the years since then, the region has been developed by numerous industrial/manufacturing facilities, commercial businesses and residential housing developments. A large glass manufacturing facility was located on the western edge of the Bermite facility and a testing laboratory (valves, rocket motors, etc.) is located on the eastern boundary.

At the present time, the area is continuing to undergo rapid development and population growth. Major population centers adjacent to the region on the south include San Fernando, Granda Hills and Chatsworth. Within the region, the largest developments are the cities of Newhall and Saugus now incorporated as the City of Santa Clarita. Numerous residential developments are located north and east of Newhall in the canyons and foothills adjacent to the Bermite facility. Residential homes are now being constructed along the southern and western property boundaries of the facility.

C. Climate

The climate in the Newhall area is a semi-arid, mediterranean-type climate with hot dry summers and moderate wet winters. In Newhall, midday high temperatures of 100°F and nighttime low temperatures of 70°F are common during the summer months. During the winter months midday high temperatures of 50°F and nighttime low temperatures of 30°F are typical. Overall, mean monthly temperatures are near 77°F during the summer and near 48°F during the winter.

The Los Angeles County Flood Control District recorded a 59 year average annual precipitation of 13.5 inches at the Saugus-Edison substation gauge No. 200. A similar station, Mint Canyon gauge No. 1009, recorded a 38 year average precipitation of 12.1 inches. The Saugus-Edison and Mint Canyon stations are approximately six miles northwest and five miles northeast of the Bermite facility, respectively.

The Los Angeles County Flood Control District has also calculated the 95-year mean annual precipitation, inclusive of the Saugus-Newhall area, based on a number of precipitation station's data. The 95-year mean for the region was determined to be 16.4 inches.

Based on the data from the precipitation stations, the Flood Control District has prepared a precipitation contour map for the Saugus-Newhall area. The Bermite facility is located in an area estimated to receive approximately 15 inches of precipitation per year.

The National Climatic Data Center has a rain gauging station near the towns of Saugus and Newhall. The annual precipitation since 1951 is shown in Table 2. This data has been graphed and is included as Figure 5. The average annual precipitation over this period of record was 17.7 inches. On average, it appears that the Bermite area receives about the average amount of precipitation recorded for the Saugus-Newhall area, 17 inches per year.

An important factor governing the effect that precipitation has on the Bermite site is the high rate of evapotranspiration that occurs in the hot semi-arid region. Data from the Department of Water Resources, Newhall and Castaic Dam stations, report mean yearly evaporation values of 1650 and 2057 millimeters of water or about 65 and 81 inches of water. The Newhall station used a type Y evaporation pan while the Castaic Dam station used a type A evaporation pan. These values indicate there is a high potential for precipitation to be lost to the atmosphere at the Bermite site. However, the Santa Clara River Valley receives about 80 percent of its annual precipitation between November and March, the months in which the potential evapotranspiration for the region is lowest. Thus, despite the high evaporation potential of the region, precipitation is in excess of evapotranspiration between November and March. The excess precipitation will either run off as surface water through one of the canyons or may recharge the underlying aquifers. According to the USGS (1972) an estimated 5 to 10 percent of the annual precipitation is direct recharge to the aquifers.

The facility does not lie within the 100 year flood plain calculated for the Santa Clara River Valley and only a portion of the facility along Soledad Canyon Road on the north lies within the 500 year flood plain. The 317 and 342 Areas do not lie within the 500 year flood plain.

D. Surface Water

The Santa Clara River provides regional drainage for the Saugus-Newhall area of Los Angeles County. The Santa Clara River then flows west across Ventura County and into the Pacific Ocean. Principal regional tributaries which drain towards the Santa Clara River from the south include the Potrero and Pico Canyons to the west of Newhall, Sand

and Oak Canyons to the east of Newhall and the Placerita and Newhall Canyons to the south of Newhall.

Immediately west of the Bermite property, the south fork of the Santa Clara River flows north towards its confluence with the main course of the Santa Clara River near Bouquet Junction. Major tributaries to the south fork of the Santa Clara River are Pico Canyon, Newhall Creek Canyon and Placerita Creek Canyon. Placerita Creek Canyon is approximately one mile south of the Bermite property. Two smaller canyons draining the Bermite property to the south and the west are the Oro Fino Canyon and the Oakdale Canyon; respectively. Flow in all of the above mentioned stream canyons are considered to be ephemeral only and thus they are dry most of the time.

No lakes exist in the immediate vicinity of the Bermite facility. The nearest lake is Castaic Lake, formed by the construction of Castaic Dam located approximately 7 miles northwest of the Bermite facility.

III. REGIONAL GEOLOGY

A. Introduction

The Bermite facility is situated within the eastern part of the Ventura basin, an elongated trough containing a thick sequence of late Cenozoic deposits that trends approximately east-west along the Santa Clara Valley in Los Angeles County. Most of the structural features within the basin, including fold axes and major faults, largely follow this trend. The main geologic features in the basin are shown on Figure 6, which is adapted from Slade (1988). This figure depicts the surface exposures and contacts of the geology in the region which has been overlaid on the USGS topographic map of the region. The two main faults shown on Figure 6, the San Gabriel and Holser faults, are the surface traces of the faults.

The Ventura basin, according to Winterer and Durham (1962), developed its linear trough character near the beginning of the Miocene epoch. The basin is bordered on the northeast by the largely crystalline rocks of the San Gabriel Mountains and on the south by the Santa Susana Mountains.

Within the eastern Ventura basin the thickest water bearing unit is the Saugus Formation which reaches a maximum thickness of approximately 8500 feet, although only a maximum of 5500 feet is estimated to be fresh-water bearing. Other fresh water bearing units in the region include the Quaternary terrace deposits and the alluvial deposits within the Santa Clara River Valley and its major tributaries.

The regional geologic description has been compiled from a number of references and is based on the advancement of a number of oil wells (both exploratory and producing) drilled in the region and on a number of municipal water wells drilled in the region over the last 30 years. The location of wells used for describing regional cross-sections is shown on Figure 7. There are numerous technical reports describing the geology in the region due to the oil exploration and production in the area. The main references used herein include Oakeshott (1950), Slade (1988) and Winterer and Durham (1962). A complete list of references is included in Section VIII below.

Slade (1988) constructed two regional cross-sections through the area that are adapted in-part herein and are presented as Figure 8 and Figure 9. These cross-sections are similar to and correlate with earlier work by Winterer and Durham (1962). The location of the Bermite facility has been indicated on both Figures 8 and 9.

Review of both Figure 8 (cross-section A-A' running southeast to northwest) and Figure 9 (cross-section B-B' running southwest to northeast) shows the trough or cup-like nature of the formations in the region. The major faults and anticlines depicted on Figure 6 are shown on the cross-sections.

Figures 8 and 9 show only the formations including the surface alluvium or terrace deposits, the Saugus Formation and the Pico Formation underlying the Saugus. The formations at greater depth are listed along with their approximate age and thickness in Table 3, a stratigraphic chart of the southeastern Ventura basin. This table also includes a brief description of the lithology of each formation. The formations are listed in chronological order from the most recent to the oldest.

B. Stratigraphy

The youngest deposits within the Santa Clara River Valley in the Newhall-Saugus area include the unconsolidated alluvial deposits and terrace deposits that range in age from Upper Pleistocene to recent. The outcrop occurrence of these largely undifferentiated deposits has four main expressions which were described by Slade (1986) as:

- floodplain and stream channel deposits
- alluvial fans along the mouths of canyons
- elevated terraces along the basin margins
- terraces within the low foothills adjoining the main river valleys.

Most of the Holocene-aged (recent) alluvial deposits within the Newhall-Saugus area occur within the Santa Clara River Valley and its tributaries. These deposits tend to have a lens-like geometry with the greatest thicknesses of strata within the center of valleys which thins or pinches-out as the flanks of adjoining ridges are approached. Within the largest valleys, thicknesses may reach 200 feet, although in smaller valleys the thicknesses are much less. Recent alluvium typically consist of poorly stratified and poorly consolidated gravels, sands, and silts. Review of Figure 6 shows these deposits occur throughout the region in the valleys. A number of alluvial valleys are mapped at the Bermite facility.

Winterer and Durham (1962) noted that, within the Ventura basin, the terrace deposits were most common along the Santa Clara River Valley . Generally these terrace deposits consist of gravel, sand, silt, with zones of large cobbles and boulders with crude horizontal to lenticular stratification. The elevated terrace deposits have generally undergone more extensive weathering than the Holocene alluvium in the region and are typically better consolidated and brown in color which results from iron oxide cementation.

Oakeshott (1950) noted that older alluvial deposits, similar in character to Holocene alluvium, has also been uplifted to form terraces. In the Placerita Oil Field, approximately two miles east of the Bermite facility, at least two stages of terrace formation has been recognized. Oakeshott (1950) considered the structurally undisturbed terrace deposits Late Pleistocene in age, coming after a mid-Pleistocene Coast Range orogenic period and prior to deposition of Holocene alluvium. Review of Figure 6 shows that the terrace formation overlies the Bermite facility, south of the San Gabriel fault. Bean (1987) estimated the thickness of the terrace deposits at the 317 Area to be 40 to 60 feet thick although the actual contact with the underlying Saugus Formation would be hard to discern because of the similar lithology of the two formations.

The Saugus Formation underlies the Holocene alluvium or the terrace deposits and is believed to range in age from Late Pliocene to Early Pleistocene. The Saugus Formation is dominantly continental in origin, consisting of channel, lacustrine, floodplain, and alluvial fan deposits. It is largely characterized in outcrop as consisting of lenticular units of light colored, buff, and brown, loosely consolidated, poorly bedded, poorly sorted conglomerates, conglomeratic sandstones, and sandstones. In addition, other lithologies include interbedded siltstones, silty sandstones, and light-brown to moderately reddish brown sandy siltstone and claystone. Cross-bedding in lenticular coarse units is a common characteristic of the Saugus Formation and sub-facies changes over small intervals would be common. As indicated above, the contact between the Saugus Formation and the overlying alluvial deposits is difficult to distinguish because of the similarity of the two units. The siltstones were described in some early oil well logs as shales or shalestones.

The cobbles and boulders of the Saugus are largely granitic in composition, but also include fragments from gneisses, schists, anorthosite, and volcanic fragments, derived from the crystalline rocks of the San Gabriel Mountains and the Tertiary sedimentary succession. It has been recognized that the average size of clasts generally decrease in size from the west to the east within the Ventura basin (Winterer and Durham, 1962).

Although most of the Saugus Formation is considered to be continental, the lower part of the formation is believed to consist of a sequence of interfingering fresh-water, continental, brackish marine, and shallow marine deposits, including some limestone beds. These deposits, were originally called the Sunshine Ranch Member by Oakeshott (1950) and were placed within the upper part of the Pico Formation, but Winterer and Durham (1962) included these strata as part of the lower part of the Saugus Formation. Oakeshott (1950) noted that the Sunshine Ranch Member could be distinguished from the overlying, undivided Saugus by color differences, in that the Sunshine Ranch Member contained greener and less red hues than did the rest of the Saugus Formation, although Winterer and Durham (1960) recognized greenish beds within the Saugus throughout much of its outcrop extent.

The contact of the Saugus Formation with the underlying Pico Formation is difficult to determine either in outcrop or in the subsurface with electric logs because of their lithologic similarity. In parts of the surface exposure, such as near Placerita Canyon, an angular discordance between the two formations can be recognized. However, over a basin-wide extent the generally continental beds of the Saugus are believed to grade into the deeper-water marine deposits of the Pico Formation.

The main factor which distinguishes the Pico and the Saugus Formation, according to Winterer and Durham (1962), is that there is a change in color of siltstone beds from olive gray or light bluish gray in the Pico to a more greenish gray in the Saugus Formation.

The Saugus Formation was deposited in response to tectonic uplift of the area which also caused the "Pico-sea" to retreat in a westward direction. The coarsest deposits of the Saugus are within the main paleochannel valleys which developed in response to uplift. Slade (1988) noted that the thickest area of sand accumulation also correspond approximately to the position of the present-day south and main fork of the Santa Clara River Valley and Castaic Creek.

C. Structure

1. Regional

In the region, the stratigraphy of the underlying formations is cup-shaped with the Saugus formation having its deepest extent approximately near the center of the region discussed herein or approximately south of Castaic Junction, northwest of the Bermite facility. This structure can be seen on the cross-sections of both Figures 8 and 9.

The base of the Saugus Formation dips from the southeast to the northwest across the region. Winterer and Durham (1962) show the base to be at an elevation of approximately sea level at approximately the area between the Placerita oil field and the southeastern corner of the Bermite property. At the very northwest corner of the Bermite property, just east of the town of Saugus, the base of the Saugus is shown by Winterer and Durham (1962) to be at an elevation approximately 5000 feet below sea level. Figure 9, from Slade (1988) shows the base to be at an elevation approximately 2500 feet below sea level. This cross-section is located approximately one-half the distance between the two cross-sections of Winterer and Durham (1962). Based on the distance between the cross-sections the dip of slope of the beds in the Saugus Formation is approximately 30° from the horizontal. This slope is shown on Figure 8.

Although the formations in the eastern Ventura basin are cup-shaped in nature, the base of the Saugus Formation does not pinch-out at the surface, but rather near the western edge slopes southwestward to westward which provides for groundwater outflow from the basin.

There are a number of anticlines and synclines indicated on Figure 6. Of particular interest is an anticline shown dipping to the northwest with an axis almost running through the 342 Area. The actual dip of the axis at this location and the slope of the beds perpendicular to the axis is not known.

Winterer and Durham (1962) show the sloping nature of the alternating beds or units that make up the Saugus Formation but do not provide an exact description of the relative location and thicknesses. This is most likely due to the variable nature of the beds as a result of their environment of deposition.

2. San Gabriel Fault

One of the main structural features within the eastern Ventura basin in the vicinity of the Bermite site is the San Gabriel fault. The San Gabriel fault is a right lateral strike-slip fault that trends generally N 65° W. It is considered to be part of the San Andreas fault system and their two histories are thought to be closely related. One characteristic of the San Gabriel fault is that no one fault trace can be followed the entire length of the fault, but that it consists rather of a series of parallel to sub-parallel fault traces. The proximity of the Bermite facility to the San Gabriel fault can be seen on both Figures 6 and 9. The fault trace is also noticeable on the aerial photographs of Appendix A. The 317 Area is situated approximately 1000 feet southwest from the surface trace of the fault.

Crowell (1952) cited evidence of right-lateral displacement up to 25 miles across the fault northwest of Castaic Junction. A contact of Tertiary and pre-Tertiary crystalline rocks exposed across the fault in this vicinity suggests a horizontal displacement of up to 2.5 miles. In the vicinity of the Placerita Oil Field, 2 miles east of Newhall, Oakeshott (1950) reported vertical displacement of up to 700 feet, on the north side of the fault.

Although present displacement indicates that the north side of the San Gabriel fault is relatively up, Oakeshott (1950) cites evidence that the pre-Saugus fault movement was reversed with the south block moving relatively up with respect to the northern block. It has been estimated that over 2000 feet of displacement has occurred with accompanying horizontal movement in pre-Saugus time. In post-Saugus time, with the movement reversed, the north block is relatively up a minimum of 1500 feet.

It is considered that the San Gabriel fault had major control on sedimentation during the Cenozoic period resulting in folding and faulting along the margins of the competent crystalline block along with rapid, relative sea level fluctuations. This is also demonstrated by rapid thickness and facies changes from marine to continental sedimentation.

In general, the regional dips of the Tertiary strata dip northwestward off of the crystalline basement. This structure has since been complicated by lower Tertiary faulting and shearing that has imposed a series of anticlines and synclines with west and northwest plunging axes. One of these faults, the Legion fault strikes NW-SE, but lies considerably southwest of the Bermite site, along the Newhall Creek Valley.

On Figure 9 the base of the Saugus Formation is shown approximately 2700 feet higher and therefore thinner on the north side of the San Gabriel fault verses the south side. In addition to the structural controls imposed by the San Gabriel fault, Weber (1987), in his mapping of Saugus Formation facies has recognized completely different petrologic facies, north of the fault verses south of the fault, near the Bermite site.

3. Holser Fault

The Holser fault occurs as an east-west trending left lateral reverse fault that dips towards the upthrown southern block. The fault extends as a surface expression from San Martinez Chiquito Canyon eastwards subparallel to the San Gabriel fault along the Santa Clara River Valley to a point where it merges with the trace of the San Gabriel fault east of the town of Saugus just inside the Bermite facility boundary. The 317 Area and 342 Area are approximately 1.8 miles southwest from the position where the Holser fault merges with the San Gabriel fault, therefore, it does not immediately affect the strata underneath the site. Like the San Gabriel fault, the Holser fault consists of a series of sub-parallel faults and is not a solitary fault trace. Left lateral offset between the Saugus and the Pico Formation is apparent in the western part of the Ventura basin across the Holser fault. Partly because of the contiguous nature of the fresh water-bearing deposits of the Saugus Formation across the Holser fault in its eastern extent, Slade (1988) did not consider the Holser fault here to act as a significant groundwater barrier as compared with the San Gabriel fault.

D. Oil Production

Oil is produced in the region from a number of oil fields. As early as 1875 oil was being produced from a well near the present town of Newhall. According to Willis (1952) oil in the Placerita was first discovered field in 1899 .

Oil is produced from several of the formations within the eastern Ventura basin. A summary of oil fields and production zones in the region is given in Table 4. Figure 10 shows the location of these oil fields.

The producing horizons principally occur in units older than the Saugus Formation - including the Modelo, Towsley, and the Pico, although the basal Saugus is productive from five oil fields in the vicinity.

The closest oil field to the Bermite facility and one of the largest in the region is the Placerita field, located approximately 2 miles east of the facility. As indicated above, the Placerita field has been producing oil for approximately 90 years. Portions of the field are located directly on the surface exposure of the Saugus Formation and also on alluvial deposits in the Placerita, Oro Fino and Quigley canyons. As will be discussed below, these are potential areas of recharge to the Saugus aquifer. Review of Table 4 shows that the depth to producing zones with in the Placerita and other nearly fields is relatively shallow (600 feet). The depths increase for those fields farther to the northwest of the Bermite facility.

Oil and gas reservoir traps occur within the region in a poorly defined west to northwest-dipping structural nose with updip closure provided by stratigraphic pinch-outs, facies changes, and unconformities. Production is limited to the north by the San Gabriel fault and to the east by the Whitney fault, a north-striking transverse fault. The Whitney fault has no surface expression and is believed to be post-Pico and pre-Saugus in age (Oakeshott, 1950). The principal production in the region is from the lower Saugus Sunshine Range Member of the Saugus Formation and from the upper beds of the Pico Formation.

Slade (1988) noted that water wells drilled in the vicinity of oil fields with shallow production (i.e. lower Saugus-upper Pico) would likely encounter either hydrocarbons or waters with elevated salinities. Most of the waste water from oil production in the area has historically been disposed of by injection into the underlying strata using water-injection wells or by discharge to surface ponds and allowed to evaporate or percolate into underlying strata. Recharge wells and surface ponds and sumps in the Placerita field are known to exist within 2000 feet of the 317 and 342 Areas.

The location of a number of former and existing exploratory, producing and waste-water injection wells were determined by review of records at the state of California, Division of Oil and Gas (DOG). Six wells were found in the vicinity of the 317 and 342 Areas on and adjacent to the Bermite facility. These wells are labeled A through F on Figure 7.

Typically the information contained in the files of these wells concerned the permitting and approval procedures required for construction, operation and abandonment of the wells. Specific information regarding the geology of hydrogeology within the upper 1000 feet of the wells was scarce. There were some lithologic descriptions, however, and these have been used in the description of the local geology below. The files of the wells which are or have been used as waste-water injection wells indicated the source and quality of the waste-water.

The records indicate that the waste water injection is typically very high in Total Dissolved Solids (TDS). Recent analysis (1986) of water to be injected showed a range of TDS values from 5000 to 33,000 mg/l. In addition, the analysis showed high levels of sodium (1700 to 10,000 mg/l), high levels of chloride (2800 to 16,600 mg/l) and high levels of the metal barium (0.8 to 19 mg/l).

Two waste-water injection wells are located hydraulically upgradient of the Bermite facility and specifically the 342 Area as will be discussed below.

IV. GEOLOGY OF BERMITE FACILITY

A. Surficial Geology

Weber (1987) recently completed an unpublished study mapping the surface geology along the San Gabriel fault encompassing the majority of the Bermite facility. They identified two sedimentary formations occurring at the facility, the terrace deposits and the Saugus Formation. Contrary to earlier investigations, Weber (1987) uses the term "Pacoima" formation in place of terrace deposits.

The terrace deposits range from clay to gravel and boulders and are Quaternary continental alluvial deposits. Weber's (1987) map shows these deposits as horizontal or near horizontal in attitude. Locally, in stream beds and local areas of ponding, thin, alluvial and colluvial deposits overlie the Terrace deposits. Generally, the Saugus Formation is exposed at the ground surface, north of the trace of the San Gabriel fault and the terrace deposits overlay the Saugus Formation south of the fault. The occurrence of the terrace deposits at the Bermite facility is indicated on Figure 6.

Robert Bean noted in Pioneer Consultants (1987), that only a surficial blanket of alluvial terrace materials of varying thickness cover the southern part of the Bermite facility, and that the actual contact between the terrace and the underlying Saugus Formation sediments is difficult to discern because of the similarity in lithology. The terrace deposits may occur as a very thin veneer only a few feet in thickness up to an estimated 200 feet thick.

According to Weber's mapping, the Bermite site is flanked to the northwest and southeast by valleys or canyons containing the Holocene alluvium discussed above. This is consistent with the alluvial deposits mapped by Slade (1986) and the USGS (1972). The occurrence of the alluvium at the Bermite site is also indicated on Figure 6.

Weber (1987) mapped five petrologic facies of the exposed Saugus Formation along the San Gabriel fault. Southwest of the San Gabriel fault trace and outcropping within 0.2 miles north of the 317 Area is Weber's eastern facies of the Saugus Formation which is the principal mapped Saugus facies southwest of the San Gabriel fault. This eastern facies of the Saugus Formation consists of interbedded conglomerate, cross-bedded sandstone, siltstone, and mudstone. The conglomerate beds reportedly are much thicker and coarser than conglomerate in Saugus units north of the fault. Boulders of anorthosite, granodiorite, and volcanic clasts were described as reaching up to 1.5 m in diameter along this long facies belt, which parallels the San Gabriel fault. Because of the environment of deposition of the Saugus Formation, it is expected that sub-facies changes would be common over small intervals as mapped by Weber (1987).

The structure of the exposed Saugus at the site and north of the San Gabriel fault is tilted steeply to the southwest at 45° to 85°, although the attitude of the terrace deposits south of the fault at the Bermite site has horizontal to very gentle dips (less than 30°).

B. Subsurface Geology

1. Borings at the 317 and 342 Areas

In June and July 1987, fifteen borings were drilled at the 317 and 342 Areas. These borings ranged from 11 to 301 feet in depth. The geologists logs of these borings are included in Appendix B. The locations of these borings are shown on Figure 11 and are labeled as BH-11, BH-12, etc.

The BH borings determined that approximately 7 to 26 feet of fill was encountered at both the 317 and 342 Areas which consist of clayey sand with gravel and rock fragments. The borings then encountered unconsolidated detrital clastic materials consisting principally of clean to clayey fine to coarse sand, locally containing quartz and granitic gravels and metamorphic and volcanic rock fragments. Much of the sand also contains abundant mica and magnetite, giving the sand a dark color. Clay interbeds were recognized in places, though not comprising a large volume of the soils encountered. Intermittent cobbles and boulders also were encountered in several borings, making drilling difficult and in places requiring drilling to be terminated. Boring BH-10 (located at the 317 Area) was the deepest boring at a depth of 301 feet (1225 feet NGVD). This boring was completed as a 2-inch diameter monitoring well but never had an indication of groundwater. Boring BH-6, (located at the 342 Area) was completed as a monitoring well to a depth of approximately 60 feet (1382 feet NGVD) and did not have a measurable groundwater level.

The BH borings were mainly drilled by the rotary air method due to the drilling difficulties of hollow stem auger drilling. This prevented a thorough description of the soils encountered. Some soil samples from these borings were collected and physical tests on these samples were performed. These test results have been previously submitted (Wenck May 1988) and are again presented herein as Table 5. The samples were sieved and the grain size distribution of those samples has been graphed and is included as Appendix C. Review of Table 5 shows that the moisture percent of the soils tested ranged from a low of 5.8 to a high of 23.2. The permeability of the soils tested ranged form 7.0×10^{-8} cm/second in the fill material to 1.0×10^{-3} cm/second at depth. 10^{-3} to 10^{-4} cm/second is representative of the non-fill soils tested.

Between April 1988 and June 1988 excavation of soils was performed at the 317 Area in an attempt to determine the horizontal and vertical extent of VOC contamination. Excavation continued until a depth of 50 feet below the former RCRA unit was reached. The soils encountered during the excavation were consistent with the description of the terrace deposits and the Saugus Formation given above. The soils were generally sands and gravels with lenticular lenses of cobbles and boulders. Some interbedded clays were evident. The lack of moisture in the soils was evident throughout the excavation. No perched groundwater was encountered. The excavation required addition of water to prevent wind blown soils in accordance with the permit granted for the excavation by the South Coast Air Quality Management District.

Following completion of excavation, vapor probes and vapor extraction vents were installed into the soils below as part of an In-situ Volatilization System. Of all the borings performed for the installation of the vapor probes, the soil boring for vapor probe P-5, which reached a total depth of 223 feet (1252 feet NGVD), contains the most useful direct lithologic information concerning the soils at depth at the 317 Area. The soil boring log from P-5 is presented in Table 6. This particular boring was not actually completed as a vapor probe because of difficulties with removing the casing, driven during drilling, so a shallower boring was drilled for the vapor probes. The locations of all probes and vents are shown on Figure 11.

Based on the boring log of P-5, the upper 60 feet of soils below the trenched area consists dominantly of sand and gravel with some clay lenses. At a depth of 60 feet to a depth of 125 feet below the surface, a zone dominated by clay or sandy clay was encountered, broken only by 13 feet of sand and gravel from 86 to 97 feet. It is this upper clay zone at 60 feet which is believed to be partially responsible for the concentration of VOC's recorded and mapped using the vapor probe nests Wenck (April 1989 and September 1989 B).

The remaining interval encountered within the P-5 boring consisted dominantly of sand with some gravel, though an additional clayey zone was encountered from 164 to 175 feet. The higher clay zone was not logged in the borings performed by Pioneer Consultants, although in the Pioneer Consultant boring BH-10 (See Appendix B) drilled on June 26, 1987 and located 150 feet west-northwest of P-5, a clay zone was reported near 185 to 190 feet below surface which may represent the same clay zone encountered in the P-5 boring.

2. Subsurface Geology As Determined From Well Logs

In accordance with the approved RCRA Closure plan and in consultation with the DHS, six groundwater monitoring wells were installed between November 1987 and July 1989. The locations for these wells are shown on Figure 11. Each well is constructed of 4-inch diameter, 20-foot long stainless steel well screens and 4-inch diameter stainless steel casings. The construction of these wells has been reported previously by Wenck (March 1988 A and August 1989 A).

Monitoring wells MW-1, MW-4, MW-5, and MW-6 are located in the vicinity of the 317 Area, with MW-1 located upgradient and monitoring wells MW-4, MW-5 and MW-6 located downgradient. Monitoring well MW-2 is located at the 342 Area. Each well was drilled by the mud rotary method and was logged by a number of methodologies. Copies of the geologists logs are included as Appendix D. Copies of all wireline logs (Gamma-Ray, Caliper, Spontaneous Potential, Resistivity) are included as Appendix E.

The various wireline logs from the monitoring wells were used to determine lithologic trends of the Saugus Formation in the subsurface beneath the Bermite facility. Using the interpreted lithologies, subsurface cross-sections were prepared displaying correlations between wells. Determination of lithologies and correlation were largely done by use of the Spontaneous-Potential curve (SP) and the Resistivity curves. The SP curve records the naturally occurring potentials in the borehole as a function of depth. The SP curve is most useful for detecting permeable beds and bedding boundaries, although there is no definite relationship between the magnitude of the SP deflection and the porosity and permeability of the formation.

Because the SP curve deflections are in part a function of salinity contrast between the drilling mud and formation water salinity, the SP deflection of freshwater and unsaturated sands are typically more depressed in comparison with salt water-bearing sands. Because of this effect in the largely unsaturated zone of the Saugus Formation, the resistivity curves provided a better correlation tool than the other wireline logs. Resistivity curves are generally a good indicator of the relative shaliness of a unit. Clays and shales have, for example, the lowest resistivity, silty units have moderate resistivity, and sand or gravel have moderate to high resistivities. Dry, unsaturated sands would typically display very high resistivities.

The most useful curves for correlation, because of the typically depressed SP character, were the resistivity curves including the resistivity detail curve. Three subsurface cross-sections through the Bermite facility were prepared using the SP and resistivity curves, C-C', D-D', and E-E' as indicated on Figure 11. These cross-sections are presented as Figures 12, 13, and 14.

Cross-section C-C' (figure 12) is drawn southwest-northeast and includes monitoring wells MW-2, MW-5, and MW-6. Cross-section D-D' (Figure 13) is drawn southeast-northwest and includes wells MW-1, MW-4 and MW-5. Cross-section E-E' (Figure 14) is drawn south-north and includes wells MW-3, MW-4 and MW-6. Each cross-section is briefly described below. Because of the close proximity of Wells MW-1, MW-4 and MW-5 on cross-section D-D' these well logs display the greatest amount of internal correlation of stratigraphy. This cross-section is, therefore, described in greater detail.

Because of the proximity of boring P-5 and boring BH-10 to Cross-section D-D' between wells MW-1 and MW-4, stratigraphic data from these borings was used to compare with the subsurface stratigraphy indicated by the logs of these wells. In MW-4 the uppermost sand body logged occurs from the top of the logging depth at the 59 foot depth (1476 foot elevation) to 144 feet (1391 elevation). This sandy sequence represents the upper sandy interval encountered in boring BH-10 and in the upper 60 feet of the P-5 boring. Based on these borings and data obtained while drilling, the upper sand unit consists dominantly of unconsolidated sand, conglomeratic sand, conglomerate and gravel, with intermittent thin layers of clay and sandy clay. It is indicated on Figure 13 as a sand and gravel formation. The base of this formation is recognizable on the logs of wells MW-1 and MW-5 although at a higher elevation in both. The correlation of the base of the unit between the three wells of Cross-section D-D' suggests that the upper sand and gravel unit is cup-shaped or lenticular with the greatest thickness occurring in the vicinity of well MW-4.

The clay interval underlying this upper sand and gravel unit is clearly recognizable in the MW-4 log as a zone of low resistivities from 144 feet logging depth (1391 foot elevation) to approximately 234 feet logging depth (1301 foot elevation) or approximately 90 feet. In boring P-5, the overall clayey interval logged in this stratigraphic position was approximately 65 feet thick. This clayey interval is noticeable on the MW-1 log and is shown as approximately 65 feet thick. The clayey interval at well MW-5 appears to be thicker than MW-4 and MW-1. All of the logs of Cross-Section D-D' show peaks within this interval suggesting interbedded sands or gravels and so this unit has been labeled as clays with interbedded sands.

Underlying this clayey interval in this cross-section is another sandy unit identified by high resistivities and SP curve deflection. In MW-4 this unit is logged from 234 feet (1301 feet elevation) to approximately 306 feet (1229 feet elevation). The top and bottom of this sand and gravel interval is also apparent in the logs of MW-5 and MW-1 with this unit thicker at MW-1 than MW-5.

This sand and gravel unit has also been logged in several of the BH borings and in the P-5 boring as the lowermost unit encountered and logged in these shallow borings. These soil borings have recognized this unit as consisting of fine to coarse grained quartz and feldspathic sands with gravel, pebbles and intermittent boulders. In addition, the boring P-5 noted a ten foot zone of sandy clay at an elevation of approximately 240 feet.

Underlying this sand and gravel formation in the subsurface, the lithologic interpretation was made from well log character in conjunction with the geologists logs (Appendix D) for the wells.

The next stratigraphic unit, continuing downwards in Cross-section D-D', is a marked interval of low resistivities and SP curve deflection. This is a clay dominated unit ranging 30 to 50 feet in thickness and the bottom of this unit is again lenticular with the greatest thickness occurring in the vicinity of well MW-4. The drillers log of MW-4 indicates some variability in lithology. Based on log character, this clay with interbedded sands interval appears to be best developed at MW-5.

The remaining logged interval of the Saugus Formation in these wells displays less stratigraphic continuity than the sand and clay units higher in the section. This interval is interpreted as consisting of sandy and gravelly units interbedded with clay and silt although the top of this interval is sandy with an underlying stratigraphically continuous finer-grained or clay unit. This unit is recognized in the MW-4 log from 410 feet to 438 feet (1125 to 1097 feet elevation). The geologists log from MW-1 and MW-4 identified sandy clay and fine to medium grained sand for this zone. There is some overlapping of the geologists logs for the wells with the stratigraphic units delineated on the cross-sections. This is consistent with the manner with which the samples are collected during mud rotary drilling and the interbedded nature of the lithologic units described herein.

The remainder of the section contains less stratigraphically continuous units and consists of sand, gravel and boulders with interbedded clay units. Although, the screened interval in MW-1 and MW-4 are set in sands, the 50 to 100 feet zone above the screened zone does appear fine grained. The geologist's log did note an increased clay and sandy clay in this zone as well.

Cross-section C-C' (Figure 12) is oriented NE-SW through the Bermite facility and extends through wells MW-2, MW-5 and MW-6. This cross-section demonstrates that a correlation of lithologies can be made between MW-5 and MW-6, but that the lithology at MW-2 is different. MW-5 and MW-6 are within 200 feet of each other and MW-2 is over 1000 feet from MW-5. Changes in lithology (facies changes) could be expected over this great of a distance.

The upper clay zone recognized in MW-4 between 144 and 234 feet, as previously noted, is sandier in MW-5 but appears well developed as a clayey zone in MW-6, north of MW-4. The thickness of the clay unit is less at MW-6 than MW-5 and again suggests the lenticular nature of the unit.

The next stratigraphic unit downward in Cross-section C-C' is the sands and gravels recognized in Cross-section D-D'. It appears as a relatively thick unit in MW-6 down to a depth of approximately 280 feet (1240 foot elevation).

Based on the log character of MW-6 the entire interval between 280 feet logging depth to total logging depth is very similar and overall finer grained with less thick well developed sandy units than higher in the section. It is estimated that the clay content is very high with thin interbedded sands and gravels appearing intermittently. This is consistent with the geologists log of this well. The average porosities and permeability through this zone, therefore, would likely be low.

The electric log and geologist's log of MW-2 suggests that the stratigraphy at this location consists predominantly of coarse sands with gravel and boulders interbedded with clayey deposits.

The screened interval in MW-2 is located higher stratigraphically than in other wells, but based on the driller's log and the electric log was set in a sandy zone. The lithology just above the screen in well MW-2, while not distinguishable from the wireline log, was determined, at the time of drilling, to be a very dense rock structure and perhaps is representative of the claystones or siltstones described above. This "rock" structure was not noticeable in the wells at the 317 Area and suggests that the lithology is different at the 342 Area.

Cross-section E-E' is oriented south-north through the 317 Area and extends through wells MW-3, MW-4 and MW-6. This cross-section again displays the lenticular nature of the correlatable units between MW-4 and MW-6. It appears that MW-3 is, overall, sandier than the other areas in the upper 275 feet. The remainder of the section consists of clays and sandy clays with interbeds of sand, gravel and boulders.

Another method of correlating both the geologist's and the wireline logs, is to compare the cuttings from the well borings collected during drilling. Cutting samples from both wells MW-5 and MW-6 were collected at 20 foot intervals throughout the two borings. The cuttings collected contained drilling muds in addition to the sands, gravels and clays of the formation. Selected samples were washed through a US sieve No. 270 (53 microns) to remove the drilling muds, silts and fine particles. A measurement was then made of the approximate maximum grain size and medium grain size of the individual soil particles comprising each sample. A vertical grain size profile has been created for each well MW-5 and MW-6 and this is presented as Figure 15.

In general, the grain size profile presented in Figure 15 correlates with the three main lithologies determined from the well logs as discussed above (sands and gravels, clay with interbedded sands and interbedded sands, gravels and clays). There is not everywhere a direct correlation but this may be attributable to the interbedded nature of the lithology and the uncertainty of the exact elevation from which cuttings are actually drilled.

As discussed above, oil wells have been drilled near the 317 and 342 Areas. Records of these wells were obtained and reviewed to verify the regional and local geology. A review of the files of these wells did not reveal sufficient information to create geologic cross-sections but did reveal some correlatable lithologic units. The most correlatable well log is from a now-abandoned waste-water injection well located southeast of the 317 and 342 Areas and is known as Thompson #1. A copy of the resistivity log of this well and the lithologic description is included as Appendix F.

This log indicates sands, gravels and clays at depth with a blue shale unit at a depth of 724 feet to 794 feet (elevation of 940 to 870 feet NGVD). This is underlain by another sand unit. The screens of the Bermite monitoring wells MW-1, MW-3, MW-4, MW-5 and MW-6 are all between elevations of 860 to 920 feet NGVD. The resistivity log of the Thompson #1 well indicates clearly the change from shale to sand at a depth of approximately 795 feet.

Well log information, from this well is also included in Appendix F. Only the lithologic description is included because the wire-line logs did not log the upper 3000 feet of this well. The lithologic log again indicates the existence of a shale unit at depth. The actual interface of this shale and overlying underlying sands is not clear from the information presented but is approximately the same or somewhat lower as shown in Thompson #1. This is consistent with the estimated dipping characteristic of the lithologic units of the Saugus Formation. A former exploratory well, known as Bermite No. 1, was drilled hydraulically downgradient of the 317 Area.

A former exploratory oil well, known as Protrana 2, was drilled at or very near to the 317 Area. No oil was found at this location. Review of the files of this well did not reveal any lithologic data. The files did indicate, however, that the well boring was abandoned by placing a cement plug at an elevation of approximately 630 to 730 feet (NGVD). The remainder of the boring, except just at the ground surface, was left open. This same abandonment procedure was followed for the former well known as Lowe #1, although it was plugged at a lower elevation (130 to 200 feet NGVD).

V. REGIONAL HYDROGEOLOGY

A. Alluvial Aquifers

1. Location

Alluvial sediments are found underlying and adjacent to the Santa Clara River Valley and tributaries leading to it. The undifferentiated alluvial or valley fill deposits are Holocene (recent) in geologic age, and are generally considered more permeable, less consolidated and less structurally deformed then the underlying formation.

Alluvial sediments are found underlying streams and generally continue beyond the stream channels until they are pinched-out up against the margins of the river valley basin. The alluvial deposits tend to spread out near the mouths of canyons forming large alluvial fans. The thickness of the alluvial sediments varies throughout the Santa Clara River Valley. According to Slade (1986), the maximum thickness varies up to 200 feet and tends to occur in the center of a canyon or river valley, thinning as it pinches-out along the adjoining hills.

Alluvial thickness in the tributary canyons is less than that in the Santa Clara River Valley and, in general, the larger the watershed area, the thicker the accumulation of alluvium. Slade (1986) noted that in smaller canyons such as Oak, Spring or Pico, the maximum alluvial thickness occurs near the confluence with the main river valley and may be only 75 to 125 feet thick. Major alluvial deposits in the region include deposits along the Santa Clara River Valley and the following tributaries to the Santa Clara River: Sand Canyon, Mint Canyon, Bouquet Canyon, Dry Canyon, Placerita Canyon, Newhall

Creek, the south fork of the Santa Clara River, Pico Canyon, San Francisoquito Canyon and Castaic Valley.

Smaller canyons, considered to contain alluvial deposits containing groundwater that border the Bermite facility are: Oro Fino on the south and Oakdale to the west. The unnamed canyon which drains from the vicinity of the 317 Area, down past the 342 Area and leads to Placerita Canyon is not considered to contain alluvial deposits. As discussed above, terrace deposits overlay the Saugus Formation in this region of the Bermite facility. Because of the elevated nature of the terrace deposits, they are not considered as potential aquifers. The placement of a well to the 60 foot depth at the 342 Area (in boring BH-6), did not detect groundwater.

2. Recharge

The water-bearing alluvial deposits in the region are generally found to be unconfined. The lack of significant amounts of clay in most of the regions alluvial deposits allows for relatively rapid recharge to the alluvial aquifers.

Natural sources of recharge to the alluvial aquifers systems include percolation of direct precipitation; infiltration of runoff in the river valleys and tributaries; subsurface inflow from adjoining hill areas and subsurface inflow from an upgradient basin. The extent to which each recharge source contributes to recharging a given section of the alluvial aquifer is site specific. Major man-made sources of recharge to the regions alluvial aquifer systems include infiltration of irrigation returns; infiltration of sanitary wastes from unsewered areas of the canyons; infiltration of water form reservoirs in the region; infiltration of wastewater treatment plant discharges to the Santa Clara river and subsequent infiltration from the river.

According to Slade (1986), no artificial recharge operations such as direct surface spreading or shallow well injection have historically been used in the region.

Recharge to the alluvial aquifer in the region most likely occurs from the underlying Saugus aquifer as a result of the hydraulic head that exists in the Saugus aquifer, which is discussed below. As will be shown, the hydraulic head, or potentiometric surface of the Saugus aquifer, in the area just east of Castaic Junction, was at an elevation of approximately 1050 feet. The base of the alluvial deposits in this area are approximately 900 feet. Because of the stratified and variable nature of the lithologic units that comprise the Saugus Formation, the recharge to the alluvial aquifer would not be expected to be continuous or equal over the region. Those areas of the alluvial deposits, which are in contact with the sands and gravels as described above, would be expected to receive much greater recharge than the clays or claystones (shales) and siltstones.

Discharge of the regions various alluvial aquifers occurs primarily by water well extractions. Slade (1986) reported that in 1985 the regions known active wells extracted approximately 24,103 ac-ft. of water. In addition, unquantified amounts of discharge are known to leave through subsurface outflow to the downstream Piru basin to the west and may occur through permeable portions of the underlying Saugus Formation. Slade (1986) states that "It is highly probable that hydraulic continuity exists between the alluvium and the Saugus Formation within which it is in direct contact. In certain areas, where claystone and shale beds directly underlie the alluvium, hydraulic continuity would be greatly reduced." Slade (1986) noted that some discharge occurs by evapotranspiration in the few areas which phreatophytes grow.

3. Flow Directions

Slade (1986), references a water level contour map prepared by the Los Angeles County Flood Control District (LACFCD) for April 1965. The map shows groundwater flowing westerly along the Santa Clara River Valley and following the valley across the region encompassing the Bermite property. The groundwater was found, in general to have a gradient of 25 to 35 feet per mile (0.005 feet per foot).

Groundwater movement was found to generally flow south in the tributary canyons lying north of the Santa Clara River, and to flow north in the tributary canyons lying south of the Santa Clara River.

Along the South Fork of the Santa Clara River, just west of the Bermite property between Newhall and Saugus, Slade (1986) reports the flow of groundwater to be in a northerly direction. In the vicinity of Newhall the hydraulic gradient of the South Fork of the Santa Clara River was found to be 175 feet per mile (0.03 feet/foot) in November 1965. The groundwater gradients then drop significantly between Newhall and Saugus as the groundwater begins to approach the regional groundwater gradient to the west along the Santa Clara River. Slade also noted that with the exception of some small irregularities in the groundwater contour pattern in the alluvium west of Saugus, the Holser fault does not seem to create a definitive barrier effect in the region.

B. Saugus Aquifer

1. Location

The Saugus Formation, which was described in detail above, underlies the region, and is exposed at the ground surface as shown on Figure 6. Oakeshott (1950), Slade (1988), USGS (1972) and others have described the Saugus Formation as consisting of alternating units of sandstones, siltstones, shales and claystones. It is known from the oil and municipal water wells advanced through the Saugus Formation that the Saugus Formation is saturated at some depth to its contact with the underlying Pico Formation which is also considered to be saturated. Limited hydrogeological investigations have been performed in the Saugus aquifer; a total of 22 wells have been drilled into the aquifer for purposes of water supply. No other investigations than Slade (1988) or USGS (1972) or groundwater monitoring wells are known to exist. It is not known at what elevation(s) the Saugus Formation changes from unsaturated to saturated conditions but the available information on these wells does not indicate the depth to or nature of the confinement. The municipal water wells drilled in the region all have indicated confined aquifer conditions. As discussed below, the values of storage coefficient, calculated from aquifer tests on the municipal wells, are indicative of confined aquifer conditions.

No definitive investigations in the region are known that have identified or mapped confined or unconfined areas of the aquifer. It would be expected that where the Saugus Formation is exposed at the ground surface and the lithologic unit is the sandstones or sands and gravels, unconfined water table conditions exist. In those areas where municipal water wells have been drilled, all through overlying alluvial deposits, the Saugus aquifer is found to be in a confined condition. As discussed below, the first encountered groundwater at the Bermite facility in the groundwater monitoring wells, at the 317 and 342 Areas, also encountered confined aquifer conditions.

2. Recharge

Recharge to the Saugus aquifer is estimated to occur from two major sources. At those locations where the Saugus Formation is exposed at the ground surface, direct precipitation and other minor sources of surface water flow are expected to directly infiltrate. Because of the lenticular and dipping nature of the interbedded units of the Saugus Formation, not all surface exposures may be expected to be sources of recharge. In those areas where claystones and shales are exposed it is expected that infiltration would be minimal. There is no known study or mapping of the surface exposure lithologies of the Saugus Formation; hence the variability of direct precipitation recharge to the Saugus aquifer is unknown.

Slade (1986 and 1988) and the USGS (1972) estimated that infiltration occurs from the overlying alluvial deposits or alluvial aquifers to the underlying Saugus aquifers. It would be expected that infiltration from overlying alluvial aquifers would be greatest in the sand and gravel units with lesser infiltration to the claystone and shale units.

At the Bermite facility, south of the San Gabriel fault, the Saugus Formation is overlain by terrace deposits. Based on the subsurface soil borings and excavation activities undertaken at the Bermite facility and the 317 Area in particular, it is not expected that recharge of the Saugus aquifer occurs in this area. No groundwater was encountered at depths equal to the elevation of Placerita Canyon to the south and west of the Bermite facility. Precipitation which falls on the Bermite facility and is not evapotranspired would most likely run off as surface runoff to the adjoining alluvial valleys where this runoff would recharge the alluvial aquifers.

To the south of the Bermite facility, Placerita Canyon contains an alluvial aquifer. This canyon is within the surface drainage area of a large area of the Bermite facility and the hills and valleys to the south of the San Gabriel fault and east of the Bermite facility and, in addition, an area south of Placerita Canyon and north of Whitney Canyon. The Placerita and Newhall oil fields are located within this surface drainage area.

3. Groundwater Flow Directions

Historically, there has been very little data collected with regard to potentiometric elevations and groundwater flow directions in the Saugus aquifer wells located in the region. The two major hydrogeologic studies in the region USGS (1972) and Slade (1988) both, however, have mapped the overall groundwater flow direction in the Saugus aquifer. These directions are based on municipal water wells which are screened over hundreds of feet through the differing lithologies and units of the Saugus Formation. In addition, some of the well screens apparently are screened in the lower portion of the alluvial aquifers. The USGS (1972) determined flow directions from 1967 and Slade (1988) determined flow direction from both 1967 and 1987. Flow directions were also presented by Bean in Pioneer Consultants (1987) for the year 1986. The flow directions that Slade determined in 1987 have been incorporated herein as Figure 16. The potentiometric elevation measurements in the Saugus aquifer in 1987 have plotted at their respective municipal water well locations and lines of equal hydraulic head have been estimated from these elevations. As with the 1967 contours, the 1987 contours show a groundwater flow direction to the northwest near the town of Newhall. The potentiometric elevations range from approximately 1050 feet to 1300 feet NGVD.

4. History of Potentiometric Elevations

Historically, the water levels in the municipal water wells, according to static water level records, have varied by up to 60 feet. The potentiometric elevations in 1987 were considered to be near an historic high point, although the elevations in 1987 were on a downward sloping trend. This may correlate with the precipitation in the region, shown earlier on Figure 5, which has been decreasing annually since approximately 1982.

5. Known Groundwater Quality

As background for describing the regional groundwater quality in the area surrounding the Bermite facility, two reports were reviewed: USGS (1972) and Slade (1988). Both reports discussed the hydrogeologic conditions in the Saugus aquifer which is present beneath the Bermite site.

On a regional scale, the Saugus aquifer is generally composed of waters with lower dissolved solids nearer the ground surface and waters with a higher dissolved solids content with increasing depth. In Slade (1988), rough calculations of the potentially usable aquifer were made in an attempt to understand the regional groundwater deposits. The calculations estimated that the regional usable water from the Saugus aquifer extends from depths of approximately 500 feet to the base of the Saugus or a maximum depth of 2500 feet (whichever is shallower). The Saugus water-bearing deposits containing fresh water vary in thickness across the region. They are 1500 feet thick north of the San Gabriel fault, 5000 feet thick south of the Holser fault, and 5500 feet thick in the area between the faults. These thicknesses imply that fairly extensive deposits of waters with higher dissolved solids exist at depths to the south and between the two faults. The general trend of increasing dissolved solids with depth is a likely phenomenon regionally in the Saugus.

Slade, however, also found areal changes in total dissolved solids (TDS) in the Saugus aquifer. Electric logs were analyzed from area oil wells which were drilled through and to depths stratigraphically lower than the Saugus Formation. Water chemistry data from water supply wells were also analyzed. From the analysis of two zones--shallow (500 to 1000 feet) and deep (2000 to 2500 feet)--Slade found areas of varying TDS. Consistent TDS between the two zones implied that the water quality at intermediate depths between the zones was also of similar quality. Only a few areas in the region northeast of the San Gabriel fault have theoretical TDS below 800 parts per million (ppm, equivalent to mg/l). In the region between the San Gabriel and Holser faults, many areas seem to exhibit water of good quality of less than 800 ppm TDS in the shallow and deeper zones. In some of the western reaches of the Saugus, water quality was lower in both zones with theoretical TDS above 800 ppm. For the region of the Saugus aquifer south of the Holser fault, widespread areas of both zones have theoretical TDS above 800 ppm exhibiting high water quality. In this region, good water quality in the deep zone of the Saugus aquifer is not as areally extensive. The area to the west, south, and east of Newhall, in particular, has theoretical TDS less than 800 ppm. Slade cautions in his report that the general areal water quality should be used only as a guide; water quality likely varies locally. This may be due, in part, to the influence of the possible connate waters referred to by Slade (1988) and the oil field waste-water disposal practices in the region. As discussed above the TDS of the injected water can be many times greater than the receiving water.

Well-specific TDS values reported in USGS report (1972) were compared to the theoretical TDS values that Slade (1988) proposed for the Saugus. In general, it is difficult to determine if the USGS (1972) values correspond to the Slade (1988) theoretical TDS values due to a lack of well depth information in the USGS report. However, the USGS (1972) report does distinguish between shallow and deep wells, especially in the region around Newhall. Between the distinguished wells, a similar conclusion to Slade (1988) can be drawn; TDS values vary areally in both the deep and shallow zones near Newhall. Specific values for TDS were reported in the USGS (1972) report. TDS concentrations for deep Saugus wells ranged from 400 to 1000 ppm. Likewise, TDS ranged from 500 to 3600 ppm for shallow wells in the Saugus.

Concentrations of several major ions found in natural waters were also reported at specific wells in the Saugus aquifer in the USGS (1972) report. Although no data was given in the report regarding the date of sampling events, a general inference about the groundwater quality in the vicinity of each well can be made from the data. The parameters and the range of values found throughout the Saugus aquifer are presented below:

Cations

sodium-10 to 180 mg/l

calcium-15 to 220 mg/l

magnesium-approx. 0 to 125 mg/l

Anions

chloride-10 to 70 mg/l

bicarbonate-160 to 320 mg/l

sulfate-40 to 1070 mg/l

Total Dissolved Solids (TDS)-243 to 3427 mg/l

In almost all areas of the Saugus aquifer with data reported, water was predominantly sodium-calcium in nature for cations. The predominant anions present in groundwaters measured throughout the Saugus aquifer appear to be either bicarbonate or sulfate. The south and south central areas of the Saugus aquifer seem to be more sulfate in nature. Most other areas, especially in the vicinity of the Bermite facility appear to be more bicarbonate in nature.

Two other considerations may be important in the regional water quality in the Saugus aquifer. Numerous oil exploration and pumping wells have been drilled through and into the Saugus aquifer. The impact of these activities to the Saugus is unknown. Potential adverse impacts to Saugus water quality could result from leaking well shafts, drilling muds, or improper disposal or leaching of oil products at the surface. Another possible condition in the region reported by Slade (1988) is the presence of connate waters. The actual amount, salinity, and quality of these waters was not reported. The impact of the connate waters on the Saugus is also unknown, but they potentially could adversely effect Saugus water quality.

Some data and conclusions in the USGS (1972) and Slade (1988) reports appear more likely to be indicative of the general Saugus groundwater quality closer to the Bermite facility. In Slade (1988), the theoretical TDS given near the Bermite site varies. In the vicinity of the 317 Area, a theoretical TDS of less than 800 ppm is shown for both the shallow and deep zones of the Saugus. In the vicinity of the 342 Area, the boundary of two different categories of theoretical TDS run approximately through the 342 Area. One of the categories, TDS less than 800 ppm at the shallow and deep zones, is the same continuous regional category as for the 317 Area. The category also bordering on the 342 site and continuing to the west of the site is for theoretical TDS less than 800 ppm only in the shallow zone. The deep zone at and to the west of site 342 would, therefore, be considered to be above 800 ppm in theoretical TDS. This suggests that the natural groundwater quality at the 342 Area may be of a different nature than at the 317 Area.

More well-specific data closer to the 317 and 342 Areas was presented in USGS (1972). For those wells labelled in the report as deep, wells numbered as 4N/16W-34A3, 4N/16W-35L1, and 4N/16W-35M2 appear to be located closest in a relatively downgradient direction from Bermite. No shallow-labelled wells appear in USGS (1972) that are likely similar and hydraulically connected to the water found beneath the Bermite site.

Water quality data in USGS (1972) for the three deep wells mentioned above indicates groundwater low in measured TDS (range of 338 to 390 ppm). The groundwater found in these wells is of a calcium-sodium-bicarbonate nature. The similarity of this water quality to that found in the monitoring wells at the Bermite site will be discussed below.

6. Known Physical Characteristics of the Saugus Aquifer

The Saugus aquifer, as discussed above, is known to increase in thickness from the southeast towards the center of the region south of Castaic Junction and then thins out again to the northwest. This same characteristic is seen from approximately the southwest direction to the northeast direction and is modified by the San Gabriel fault. The Saugus Formation is approximately 8500 feet thick near the center of the region and pinches-out at the surface exposure of the Saugus Formation as indicated on Figure 6. Both the USGS (1972) and Slade (1988) have mapped the thickness of the fresh water portion of the Saugus aquifer in the region. This thickness is somewhat arbitrary as it was used for purposes of municipal well development in the region. However, this calculation is instructive as to the shape of the Saugus aquifer in the region. Figure 17 provides the estimated thickness of the Saugus aquifer and has been adapted from Slade (1988). Review of Figure 17, indicates the maximum thickness of the fresh water bearing deposits of the Saugus Formation is in the range of 5500 feet with these thicknesses decreasing radially from that location. In the vicinity of the Bermite facility the thickness of fresh water-bearing deposits ranges from less than 500 feet to greater than 3000 feet. The log of an exploratory oil well at the Bermite facility in 1950, labeled as P-17 on Figure 7, indicated the thickness of the freshwater deposits as 2020 feet.

Limited aquifer tests have been performed in the Saugus aquifer including tests performed by the USGS (1972) and Slade (1988). Values of aquifer transmissivity and storage coefficient were either determined from actual aquifer tests or were developed through a mathematical model using oil well electric logs. The range of values for transmissivity and storage coefficient determined by the two investigations are shown in Table 7. It can be seen that transmissivity in the region has been estimated from 3300 gallons per day per foot to a maximum of approximately 200,000 gallons per day per foot. Storage coefficient values have ranged from .0008 to .0025. It is generally agreed in the literature that storage coefficients of this magnitude are indicative of confined aquifer conditions.

The wide range in transmissivity values can be attributed to a number of factors. The municipal wells used in the aquifer tests are all screened at different depths and have differing lengths of perforations. In addition, the pumping rate of the aquifer tests performed varied from well to well and the thickness of the aquifer and the actual lithology screened are not the same at each well.

Major geologic features which provide undocumented hydrogeologic control to the Saugus aquifer are the existence of faults, anticlines, synclines and resulting dips of the beds or units within the Saugus Formation. Generally in the vicinity of the Bermite facility the lithologies of the Saugus aquifer are considered to dip to the northwest at an angle up to 30°. Very near the fault trace the beds may dip upward to 90° or more and can be complicated by multiple fault traces. As shown on Figure 9, the Saugus Formation is offset across the San Gabriel fault and according to Wenck (May 1988) and Slade (1988) the fault most likely provides an effective barrier to groundwater flow from the north to the south of the San Gabriel fault.

C. Water Usage

1. Public Water Supply Wells

As indicated above there have been approximately 22 municipal water wells drilled into the Saugus aquifer. A number of these wells have been abandoned so that, at present, between 8 and 10 wells are used for public water supply. These wells are located in a line approximately southeast - northwest from the town of Newhall to the intersection of the Santa Clara River and Interstate Highway 5 south of Castaic Junction. Average production from the municipal water wells has been approximately 4600 acre feet per year, Slade (1988).

2. Other Uses

Historically, ranches and some industries in the area have produced water from the Saugus Formation, although little information is available as to the location and actual production volumes. Slade (1988) estimated that total production by other users was estimated at less than 100 acre feet per year or approximately 2% of the total volume withdrawn on an annual basis.

VI. LOCAL HYDROGEOLOGY

A. Occurrence of Groundwater

1. Depth to First Encountered Groundwater at the 317 and 342 Areas

The construction of the groundwater monitoring wells at the 317 and 342 Areas encountered groundwater at depths between approximately 460 and 675 feet which corresponds to elevations of approximately 960 feet and 860 feet, respectively. The higher elevation of the first encountered groundwater occurred at well MW-2 (at the 342 Area) and the elevation of first encountered groundwater was essentially constant for wells 3, 4, 5, and 6 (at the 317 Area). The elevation of the first encountered groundwater at well MW-1 was approximately 60 feet higher than the other wells at the 317 Area. The ground and screen elevations of the groundwater monitoring wells at the Bermite facility are presented in Table 8.

The cross-sections created from the well logs of the Bermite monitoring wells were presented as Figures 12, 13 and 14 have been redrawn and are presented as Figure 18, 19 and 20. The figures schematically show the location of the first encountered groundwater in addition to the potentiometric elevation measured in January of 1990.

The depth to or elevation of the saturated soils at the 317 and 342 Areas (860 to 960 feet NGVD) are below the elevation of the ground surface in the Placerita Canyon south of the Bermite facility. Ground surface elevations between 900 and 1000 feet do not occur in the region except northwest of the Bermite facility west of Castaic Junction.

2. Potentiometric Elevation History

The present groundwater elevations as of January 1990 are indicated on Figures 18, 19 and 20. As discussed below, the potentiometric elevations of the monitoring wells at the Bermite facility are collected on a quarterly basis and have been since late 1987. A graph of the potentiometric elevations over the last 2 years is presented on Figure 21. It can be seen that the hydraulic head has been dropping over the period of record at nearly a constant rate. The elevations have dropped approximately 15 feet over the two years of the period. These elevations correlate with the potentiometric elevations determined by Slade (1988) which were presented in Figure 16. At the time that Slade created his potentiometric contours, he did not have available the groundwater monitoring well data at the Bermite facility. Therefore, his potentiometric elevation contours are not projected onto the Bermite facility. If extrapolated, however, the 317 and 342 Areas lie between his potentiometric elevations of 1100 to 1150 which correlates with the late 1987 elevations of 1105 to 1110 feet elevations.

3. Seasonal and Temporal Influences

The influences on the potentiometric elevations of the Saugus aquifer at the Bermite facility are most likely due to the recharge occurring to the aquifer. As discussed above, the annual precipitation has been decreasing in magnitude over the last decade. The annual precipitation in 1989 was approximately 25% of the annual precipitation in 1982.

B. Local Aquifer Characteristics

1. Total Depth of Aquifer

Based on the cross-sections Figure 8 and Figure 9, the total depth of the Saugus Formation at the Bermite facility and specifically at the 317 and 342 Areas is approximately 4000 feet. The depth of the fresh water-bearing aquifer is estimated to be 1400 feet. The thickness of the aquifer increases to the northwest of the 317 and 342 Areas. Based on the depth to the first encountered groundwater at the 317 Area, the thickness of fresh water-bearing deposits at the 317 Area is approximately 700 feet.

2. Transmissivity

Transmissivity values for the Saugus aquifer at the 317 and 342 Areas have been calculated, from pumping tests of the Bermite wells, and previously reported by Wenck (March 1988 A, August 1988 and September 1989 A). These values of transmissivity are summarized on the attached Table 7. The range of values calculated was from 970 to 31000 gallons per day per foot. These values were calculated from wells that are screened in only a fraction of the aquifer.

Transmissivity values in the Saugus aquifer were calculated by the USGS (1972) and are presented herein as Figure 22. The location of the 317 and 342 Areas are shown on this Figure. For that portion of the Saugus aquifer underlying the Bermite facility, the calculated values for transmissivity are just at the transition from a range of 2000 to 25000 up to 75000 gallons per day per foot.

The values calculated by Wenck from aquifer tests of Bermite wells and fall within the range calculated by the USGS (1972). The variability of the values is likely due to the low pumping rates during the aquifer tests of wells MW-1 and MW-2 and the initial test of well MW-4. In addition, the lenticular nature of the Saugus Formation likely results in the screens of the monitoring wells being screened in interbedded units of slightly different hydraulic characteristics. The transmissivity values calculated by the USGS (1972) and by Slade (1988) were based on wells that are screened through hundreds or thousands of feet of the Saugus Formation and are, therefore, values representative of a greater thickness of the aquifer.

3. Storage Coefficient

Values of storage coefficient for the Saugus aquifer at the 317 and 342 Areas were calculated from the results of an aquifer test performed by Wenck, (September 1989). A summary of the storage coefficients calculated is presented in Table 8. The values of storage coefficient are similar in magnitude to those calculated by Slade (1988) and the USGS (1972). Values of storage coefficient less than .005 are considered representative of confined aquifer conditions.

C. Groundwater Flow

1. Direction

Based on the potentiometric surface elevations, measured on a quarterly basis in the groundwater monitoring wells at the 317 and 342 Areas, the lateral groundwater flow direction has been calculated. The most recent elevations and the resultant flow direction are given on the attached Figure 23. It can be seen that the lateral flow direction is approximately northwest from the 317 Area. This is approximately the same direction as shown regionally by USGS (1972), Pioneer Consultants (1987) and Slade (1988).

The potentiometric contours at the 317 Area have not been extrapolated to the 342 Area for lack of monitoring wells other than well MW-2 and because this well is screened at an elevation approximately 100 feet above those wells at the 317 Area.

2. Groundwater Flux

Based on the potentiometric elevations and the distance between the groundwater monitoring wells the hydraulic gradient of the potentiometric surface is 0.002 feet per foot.

Assuming that the calculated values of transmissivity of approximately 1000 to 31,000 gallons per day per foot are representative of the full thickness of the freshwater saturated aquifer at the 317 Area (approximately 725 feet), estimated values of lateral hydraulic conductivity range from 0.17 feet per day up to 5.7 feet per day. Hydraulic conductivity was calculated by the following:

$$k = \frac{T}{b} \quad \text{where} \quad \begin{aligned} k &= \text{Hydraulic conductivity} \\ b &= \text{Thickness} \\ T &= \text{Transmissivity} \end{aligned}$$

Aquifer permeability was also calculated from the results of the aquifer test reported in Wenck (September 1989). The interpretation of the aquifer results is, however, different herein than presented in Wenck (September 1989). Instead of assuming a two-dimensional aquifer with an assumed thickness, a three dimensional analysis was made using the results of the aquifer test as input.

The three dimensional analysis, which is described by Strack (1989), was used for analyzing the present groundwater remediation program discussed below. A complete description of the analysis is present as Appendix G.

An intermediate result of this analysis is a value for aquifer permeability which has the same units as hydraulic conductivity (feet per day). The value of permeability calculated is 1.7 feet per day.

3. Hydrogeologic Controls

a. Faults

The major faults described above, the San Gabriel and Holser faults, were shown to provide discontinuities to the lithologies of the Saugus Formation. The units that make up the Saugus Formation are estimated to dip up to 90° along the fault with lesser amounts farther away from the faults. The faults therefore are estimated to provide hydrogeologic control to the flow of groundwater. Horizontal and vertical hydraulic conductivities have been altered and near the faults may have been reversed. At the 317 Area the San Gabriel fault most likely provides control to the flow of groundwater such that groundwater would be prevented from flowing in the northerly or northeasterly direction.

b. Confining Beds

The lenticular and stratified nature of the Saugus Formation; alternating layers of sands and gravels with siltstones and claystones (shales) suggests that the lateral hydraulic conductivities vary by elevation. The intrinsic permeability of the claystone and shale units within the Saugus Formation undoubtedly provides some form of hydrogeologic control. The slope or dip of the units of the Saugus Formation at 317 Area most likely results in an overall flow direction that is parallel to the dipping nature of these beds.

D. Quality of Groundwater at the 317 and 342 Area

For most of the six major ions common to natural waters and for total dissolved solids (TDS) as reported in USGS (1972), limited data has been gathered for monitoring wells at the Bermite site. Comparisons can be made to the USGS (1972) data based on past and recent groundwater quality data for the monitoring well network.

Analysis for TDS was not conducted during past groundwater quarterly sampling events, however, a commonly used relation:

Total Dissolved Solids (TDS) (in ppm) = 0.65 [Specific Conductivity (in umhos/cm)]

can be used to compare monitoring well data. The relation can be used to compare the data for specific conductance to the TDS data reported for nearby water wells in USGS (1972). The relation above uses a typical factor in the translation from specific conductance to TDS (USGS, 1978). The specific conductance values reported historically for MW-1, MW-3, MW-4, MW-5, and MW-6 are in the range from 495 to 730 umhos/cm (values for conductance at MW-2 will be discussed separately). Using the relation between TDS and conductance, this range becomes 322 to 475 ppm for TDS. This range is reasonably near the range expected for the Bermite area based on the nearby water well data (range of 338 to 390 ppm TDS) discussed above. These calculated TDS values appear indicative of natural waters in the region.

Recently, TDS was analyzed in the Bermite wells MW-2, MW-3, and MW-4. The TDS values measured in the wells were 2428, 404, and 352 ppm, respectively. The values for MW-3 and MW-4 fall very near or within the range of TDS values reported by USGS (1972) in the nearby deep water wells (TDS values at MW-2 will be discussed separately below). The TDS readings for MW-3 and MW-4 appear to be indicative of natural waters in the region.

Only a few of the six major ions reported in USGS (1972) have been historically analyzed for in the Bermite monitoring program. Besides the limited historical data, however, all six major ions reported by the USGS (1972) were analyzed for during the recent sampling event in MW-2, MW-3, and MW-4. This most recent data can be compared to the USGS (1972) data from the nearby deep water wells. Both the limited historical data from USGS (1972) and the recent data for MW-2, MW-3, and MW-4 for the six major ions will be discussed in the following paragraphs.

The anion sulfate, analyzed regularly over the history of Bermite monitoring activities, shows a range of 7 to 74 mg/l in MW-1, MW-2, MW-3, and MW-4. This range falls within expected, albeit lower, concentrations based on the nearby deep water wells showing sulfate concentrations of approximately 80 to 110 mg/l. In the recent sampling event, sulfate was measured at 10, 67, and 34 mg/l in MW-2, MW-3, and MW-4, respectively. These readings are consistent with historical data and within expected natural concentrations. Also, data from the USGS (1972) suggests that the sulfate ion for waters at the site would be at low concentrations.

The chloride anion was analyzed once in the past groundwater quarterly sampling program. Chloride concentrations in MW-1 and MW-3 were measured at 83 and 35 mg/l, respectively. Chloride in MW-2 was measured at 1135 mg/l. Chloride concentrations at MW-2 will be discussed separately below. For MW-1 and MW-3 measured chloride concentrations appear to be typical of natural waters in the region; as a comparison, nearby deep water wells in USGS (1972) showed chloride levels of approximately 30 to 40 mg/l.

During the recent sampling event chloride was measured in MW-2, MW-3, and MW-4 at concentrations of 1230, 46, and 67 mg/l, respectively. The recent data for MW-3 and MW-4 are consistent with past historical data and fall near the range reported for the deep water wells. Waters at MW-3 and MW-4 appear to be indicative of natural waters in the region.

Bicarbonate, the one additional major anion, was not analyzed during past quarterly sampling events. During the recent sampling event, however, bicarbonate was analyzed for in MW-2, MW-3, and MW-4. Bicarbonate was measured in these wells at concentrations of 216, 250, and 214 mg/l, respectively. In USGS (1972), the nearby deep water wells were reported with bicarbonate concentrations ranging from 170 to 210 mg/l. Although the concentrations in MW-2, MW-3, and MW-4 were found at levels somewhat higher than those reported by USGS (1972), these values still appear indicative of a natural water of a bicarbonate nature (when compared to the relative concentrations found for sulfate and chloride and excepting the chloride levels found in MW-2).

One cation, sodium, was analyzed for in the past monitoring program. Typical sodium concentrations in MW-1, MW-2, MW-3, and MW-4 were found between 40 to 78 mg/l. These sodium concentrations appear to be typical of natural waters in the region; as a comparison, nearby deep water wells in USGS (1972) had sodium levels of approximately 50 to 55 mg/l.

Additionally, sodium was measured in MW-2, MW-3, and MW-4 during the recent sampling event at concentrations of 86, 46 and 67 mg/l, respectively. These recent data are consistent with past historical data and fall near the range reported for the deep water wells. Waters at MW-3 and MW-4 appear to be indicative of natural waters in the region.

Two cations, calcium and magnesium, were measured during the most recent sampling event. Calcium was found in MW-2, MW-3, and MW-4 at concentrations of 525, 65, and 40 mg/l, respectively. As a comparison, calcium concentrations were reported by USGS (1972) for the nearby deep water wells in the range of 55 to 65 mg/l. The water analyzed at MW-3 and MW-4 appears to be indicative of natural waters in the region.

The final cation, magnesium, was measured at MW-2, MW-3, and MW-4 during the most recent sampling event at concentrations of 118, 14 and 8.5 mg/l, respectively. As a comparison, magnesium concentrations were reported in USGS (1972) for the nearby deep water wells from approximately 10 to 20 mg/l. The water analyzed at MW-3 and MW-4 appears to be indicative of natural waters in the region.

The waters sampled and analyzed in the monitoring system overall appear to be indicative of natural waters found in the vicinity of the Bermite site. Concentrations for the six major ions found in natural waters generally indicate a water of a calcium sodium bicarbonate nature. Waters of this nature were likewise reported in USGS (1972) in the nearby deep water wells of closest proximity to the Bermite site. TDS, or the calculated TDS, found in the monitoring wells also appear to be reasonably close to the range of TDS reported by the USGS for the nearby deep water wells.

The water quality reported for MW-2 appears to be quite different than that reported for the other monitoring wells and maybe the result of the different lithology at the 342 Area compared to the 317 Area. Including the most recent sampling data, the data ranges for MW-2 for the major cations, anions, and TDS (including TDS calculated from specific conductivity) are shown below:

Cations
- sodium-78 to 86 mg/l
- calcium-525 mg/l
- magnesium-118 mg/l

Anions
- chloride-1135 to 1230 mg/l
- bicarbonate-216 mg/l
- sulfate-8 to 67 mg/l (only one data point greater than 17 mg/l)

Total Dissolved Solids (TDS)-2428 ppm

Calculated Total Dissolved Solids (TDS)-2369 to 2794 ppm

These values do not indicate the calcium-sodium-bicarbonate waters found at the other monitoring wells. Instead, the above data implies that the waters at MW-2 are of a calcium-chloride nature. Natural calcium-chloride waters have been found in certain conditions. Such conditions which might allow for this type of waters to exist are reported in USGS (1978). Those conditions mentioned include the presence of clays or shales as a means of selectively retarding the movement of the relatively large chloride ions as groundwaters pass through the material. Such shales were encountered near the final depth to which MW-2 was drilled. The USGS (1978) report also suggests that calcium would be the most likely cation attracted to cation-exchange sites in the layer.

This suggests a possible reason for the presence of the calcium chloride waters found at MW-2.

Two other features of the local hydrogeology also may impact the groundwater quality at MW-2. The location of MW-2 is much closer to the axis of an anticline in the Saugus (Slade, 1988) than the other Bermite monitoring wells. This could be reflected in the depth to which MW-2 had to be drilled relative to the other monitoring wells. MW-2 is screened in the first encountered groundwater up to 100 feet higher than the wells at the 317 Area. Although potentiometrically, the groundwater in the entire monitoring well network is similar, groundwater in MW-2 may be under the influence of some localized geological feature separate from the rest of the network. The close proximity of well MW-2 to the axis of the anticline in the Saugus aquifer may also result in a dome-like structure at or near well MW-2. If such a dome exists, connate waters as reported by Slade (1988) in the Saugus region may be or have been present near MW-2. Such connate waters may explain the origin or presence of the high chloride concentrations found at this well.

The presence of barium in MW-2 also reported in the past monitoring program may also be explained by the existence of a geologic unit with selective permeability to ionic species. Barium, as a divalent ion like calcium and magnesium, may also be expected to be attracted to the cation-exchange sites in the shales. Connate waters could also have concentrated natural deposits of barium, calcium, or magnesium. TDS and concentrations of the other major cations reflect the calcium chloride waters at MW-2.

The presence of the oil field waste-water injection wells hydraulically upgradient of the 342 Area May contribute to the difference in water quality between the 342 and 317 Areas.

As discussed above, the quality of injected waters into waste-water injection wells and surface sumps and ponds is very high in TDS, chloride and barium. Copies of injected water analysis reports are included as Appendix F.

In addition to the waste-water injection, the cements used for abandoning non-production or useable wells are high in calcium-chloride.

E. Contaminant Pathways

1. Vadose Zone

It was calculated by Wenck (May 1988) that the rate of water movement in the vadose zone soils at the 317 Area would be approximately .0044 feet per day. Because TCE is more dense than water and has a relatively low affinity to be adsorbed by the soil particles it can be expected that the downward rate of TCE migration may be greater than water. The cross-sections of Figures 18, 19 and 20 suggest that liquid contaminants may be dispersed as they encounter the clay units during downward migration. In particular, the slope of the upper clay units at the 317 Area suggests that, if lateral dispersion occurs along the top of these units, a low point occurs in the vicinity of well MW-4. However, it was shown in the documentation reports for the excavation activities at the 317 Area (Wenck April 1989 and September 1989 B) that the VOC contamination in the subsurface soils was generally confined to the 317 Area. There was no noticeable wide-spread lateral dispersion of the TCE contaminated soils.

2. Saturated Zone

Contaminants in the groundwater of the Saugus aquifer can be expected to migrate by advection and dispersion in the general direction of groundwater flow. Because of the nature of the geologic units that comprise the Saugus Formation (alternating units of sands and gravels with less permeable clays and siltstones), it can be expected that there would be greater lateral dispersion than vertical migration. The liquid density of water and TCE, even up to the solubility limit of 1100 mg/l, is essentially the same as water with no TCE. Therefore, vertical movement of the TCE, other than along with vertical groundwater movement, would not be expected.

VII. EXISTING GROUNDWATER MONITORING AND REMEDIATION PROGRAM

A. Location of Monitoring Wells

The existing groundwater monitoring wells at both the 317 and 342 Areas were selected based on the estimated groundwater flow direction from 1986. These wells are located such that monitoring well MW-1 is located hydraulically upgradient of the 317 Area and monitoring wells MW-4, MW-5 and MW-6 are located hydraulically downgradient of the 317 Area. Monitoring well MW-2 is located hydraulically downgradient of the 342 Area. Monitoring well MW-3 is located cross-gradient from the 317 Area. The screens of these wells were placed just into the first encountered groundwater. As indicated above, the elevations of these wells are given in Table 8.

All groundwater monitoring wells at the Bermite facility were placed after discussion and in consultation with the DHS.

B. Present Groundwater Monitoring Program

The present groundwater monitoring program was approved by the DHS in 1987 and modified by the DHS in October 1989. At present, all six groundwater monitoring wells are analyzed for the groundwater contamination indicator parameters of pH, specific conductance, total organic carbon (TOC) and total organic halogens (TOX). In addition, the three downgradient wells of the 317 Area are analyzed for VOCs by EPA method 624. The wells MW-1, MW-2 and MW-3 are analyzed by Inductively Coupled Plasma (ICP) for fourteen metal compounds. The analysis are made at quarterly intervals and are guided by the approved Groundwater Sampling and Analyses Plan, dated August 1988.

The sixth quarterly groundwater sampling event occurred in January 1990 and the report of these results will be submitted soon. The seventh quarterly groundwater sampling event occurred in April 1990 and the analytical results are now being received.

C. Present Groundwater Remediation Program

As a result of the detection of TCE in monitoring well MW-4 during the April 1989 quarterly sampling event (third quarter of sampling) a groundwater remediation program has been instituted.

The groundwater remediation program in place has resulted in the reduction of the concentration of TCE in monitoring well MW-4 to almost non-detectable levels.

At present, the remediation program consists of pumping monitoring well MW-4 at a rate of approximately 1.5 gallons per minute, filtering this pumped water through a granular activated carbon (GAC) filter and discharging the pumped and treated water to the ground surface hydraulically downgradient of the 342 Area. NPDES permit No. CA0061069 was issued for this discharge by the Los Angeles Regional Water Quality Control Board.

The trend of the TCE concentrations in well MW-4 is presented as Figure 24. This figure suggests that the presence of TCE in well MW-4 is not the result of a continuous source of TCE. The concentration of TCE increased from non-detectable to a maximum of 7200 μg/l. The most recent analytical results, from the seventh quarterly sampling event, detected TCE at only 7.8 μg/l or three orders of magnitude less.

The effect that pumping well MW-4 has on the groundwater flow regime at the 317 Area has been modeled using the results of the aquifer test performed and originally reported in Wenck (September 1989 1A). The analysis of the groundwater flow regime is presented as Appendix G. This analysis includes a schematic representation of the capture zone of well MW-4 at a pumping rate of 1.5 gallons per minute. This analysis suggests that the radius of influence of this pumping rate extends up to 115 feet downgradiant of well MW-4, approximately 160 feet directly cross-gradient to the pumping well and up to 230 feet at a distance sufficiently upgradient of the former surface impoundment at the 317 Area.

VIII. REFERENCES

Barton, Cecil L. and Sampson Norman N., (1949). Placerita Oil Field, California Division of Oil and Gas, Summary of Operations, California Oil Fields, Vol. 35, No. 2.

Bean, Robert T. and Meredith/Boli and Associates, Inc., (20 February, 1986). Hydrogeologic Literature Summary for the Bermite Facility. Attachment I of Part B Application.

Brown, Arthur B. and Ken, W.S.W., (August , 1932). Occurrence of Oil in Metamorphis Rocks of San Gabriel Mountains, Los Angeles County, California. Bulletin. Amer. Assoc. Petrol. Geol., Vol. 16, No. 8

Bryan, F.L., (1950). Application of Electric Logging to Water Well Problems. Water Well Journal, Vol. 4, No. 2.

Crowell, John C., (October 1952). Probable Large Lateral Displacement on San Gabriel Fault, Southern California. Bulletin. Amer. Assoc. Petrol. Geol., Vol. 36, No. 10.

Department of Water Resources., (November 1979). Evaporation from Water Surfaces in California. Bulletin 73-79.

Fetter, C.W. Jr. (1980). Applied Hydrogeology, Charles Merrill Publishing Company, Columbus, Ohio.

Heim, John D., Study and Interpretation of the Chemical Characteristics of Natural Water, Second Edition, Geological Survey Water-Supply Paper 1473, (1978).

Mefferd, M.G., Newhall - Potrero Oil Field. California Division of Oil and Gas, Summary of Operations, California Oil Fields.

Oakeshott, Gordon B., (1950). Geology of the Placerita Oil Field, Los Angeles County, California. California Journal of Mines and Geology, Vol. 46, No. 1.

Pioneer Consultants (1987). Subsurface Investigative Program, Whittaker Corp., Bermite Division.

Schlumberger, Log Interpretation, Vol. II - Applications, (1974).

Log Interpretation, Vol. I - Principles, (1972).

REFERENCES (continued)

Slade, Richard C., (February 1988). Hydrogeologic Assessment of the Saugas Formation in the Santa Clara Valley of Los Angeles County, California. Vol. 1 and Vol. 2 (Sections 1 and 2),

(December 1986) Hydrogeologic Investigation Perennial Yield and Artificial Recharge Potential of the Alluvial Sediments in the Santa Clarita River Valley of Los Angeles County, California. Vol. 1 and Vol. 2 (Sections 1 and 2).

Strack, Otto D.L. (1989) Groundwater Mechanics, Prentice-Hall, Inc., Englewood Cliffs, N.J.

Tudor, Richard B., (1962). Recent Developments in the Kraft-York Area of Placerita Oil Field.

United States Department of the Interior Geological Survey (USGS), (February, 1972). Water-Resources Investigation Using Analog Model Techniques in the Saugus-Newhall Area Los Angeles County, California.

Weber, F.H., 1987, Plate 6A: Detailed Geologic Map and Cross Sections Along the San Gabriel Fault Between Bouguet Junction and Sierra Highway, Los Angeles County, California, in Final Technical Report to U.S. Geological Survey: Part III San Gabriel Fault.

Wenck Associates, Inc.,

— (April 1987). Revised RCRA Closure Plan.

— (March 1988 A). Groundwater Investigation at the 317 and 342 Areas.

— (March 1988 B). Verification Sampling Results at Selected RCRA Units.

— (May 1988). RCRA Groundwater Monitoring System Proposed Final Configuration (Well MW-4).

— (June 1988). Soil Characterization at the 317 Area Progress Report No. 2.

— (August 1988). Documentation Report, Construction and Development of RCRA Groundwater Monitoring Well 4.

--- (December 1988). RCRA Groundwater Sampling, Quarterly Report No. 1, Volumes I, II & III.

--- (February 1989). Subsurface Vapor Probe Plan 317 Area.

--- (March 1989). RCRA Groundwater Sampling, Quarterly Sampling Report No. 2.

--- (April 1989). Vapor Probe Construction and Measurements at the 317 Area.

--- (June 1989 A). Interim Response Action Plan, 317 Area Soil and Groundwater Remediation.

--- (June 1989 B). Specific Plan, Groundwater Quality Assessment Program.

--- (July 1989). RCRA Groundwater Sampling Quarterly Sampling Report No. 3.

--- (September 1989 A). Construction and Analysis of Gradient Control Well PW-1 and RCRA Groundwater Monitoring Wells MW-5 and MW-6.

--- (September 1989 B). Construction of Vapor Extraction Vents and Vapor Probe Nests at 317 Area.

--- (September 1989 C.) Health Risk Assessment 317 Area.

--- (September 1989 D). Health Risk Assessment. Three RCRA Units: Burn Area; Durn Cage, Pans and Rails Area; and East For Area.

--- (September 1981 E). RCRA Groundwater Sampling. Quarterly Sampling Report No. 4.

--- (October 1989). Attachment 1. Statistical Analysis Well MW-2 Versus MW-1 and MW-3.

--- (March 1990). RCRA Groundwater Sampling. Quarterly Sampling Report No. 5.

Willis, Robin, Placerita Oil Field, Claifornia Division of Oil and Gas, (January, 1952).

Winterer, E.L. and Durham D.L., Geology of Southeastern Ventura Basin, Los Angeles County, California. U.S. Geological Survey Professional paper 334-H, (1962).

TABLES

TABLE 1

Physical, Chemical, and Fate Constants
of Organic Compounds from Former Surface Impoundment at 317 Area

Bermite Division, Whittaker Corporation

Substance	Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm m^3/mol)	K_{oc}	K_{ow}	MP	BCF
Acetone	10^6	2.7×10^2	2.06×10^{-5}	0.36	0.58	1.03×10^4	0.41
Carbon Disulfide	2.94×10^3	3.6×10^2	1.23×10^{-2}	42.66	69.18	0.19	19.5
Carbon Tetrachloride	7.57×10^2	90	2.41×10^{-2}	269	437	0.03	60.26
Chloroform	8×10^3	1.51×10^2	2.87×10^{-3}	57.54	93.33	0.92	18.62
1,1-Dichloroethylene	2.25×10^3	6×10^2	3.4×10^{-2}	65	69.18	0.06	5.6
1,2-Dichloroethylene (cis)	8×10^2	3.5×10^2	7.58×10^{-3}	110	178	0.02	5.01
Ethyl Benzene	1.52×10^2	7	6.43×10^{-3}	1100	1410	-0.02	37.5
Methyl Ethyl Ketone	2.68×10^5	77.5	2.74×10^{-5}	1.12	1.82	3.09×10^3	0.93
Methyl Isobutyl Ketone	1.7×10^4	6	4.64×10^{-2}	20.42	13.18	1.39×10^2	0.78
Methylene Chloride	2×10^4	3.62×10^2	2.03×10^{-3}	8.8	19.95	6.28	5
Styrene	3×10^2	9.5	6×10^{-2}	191	117	0.17	16.22
Tetrachloroethylene	1.5×10^2	17.8	2.59×10^{-2}	364	398	0.02	31
Toluene	5.15×10^2	28.1	6.37×10^{-3}	300	489.79	0.06	10.7
1,1,1-Trichloroethane	4.4×10^3	57.9	9.1×10^{-3}	152	316.23	0.50	5.6
1,1,2-Trichloroethane	4.5×10^3	30	1.17×10^{-3}	56	316.23	2.68	5
Trichloroethylene	1.1×10^3	57.9	10^{-2}	92.68	214.6	0.21	17

TABLE 1
(continued)

Physical, Chemical, and Fate Constants
of Organic Compounds from Former Surface Impoundment at 317 Area

Bermite Division, Whittaker Corporation

Substance	Solubility (mg/l)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm m^3/mol)	K_{oc}	K_{ow}	MP	BCF
Trichlorofluromethane	1.1×10^3	6.67×10^2	1.13×10^{-2}	159	338.84	0.01	7.59
Xylenes (total)	1.98×10^2	10	7.04×10^{-3}	1120	1820	0.02	178

Key:

K_{oc} - Soil-water chemical adsorption coefficient [$>10^2$ indicates tight bonding to soil]
K_{ow} - Octanol/water parting coefficient [>10 compound considered hydrophobic and lacks affinity for aqueous phase]
MP - Migration Potential [$>10^5$ extremely mobil, 1 to 10^5 very mobil, 10^{-5} to 1- slightly mobil]
BCF - Bioconcentration Factor - Concentration of compound at equilibrium in organism/Mean concentration of chemical in soil [$<10^4$ - low bioconcentration potential]

Note: Data compiled from the following references:

1. Lyman, W., et al. "Handbook of Chemical Property Estimation Methods", McGraw-Hill, New York, 1982.
2. Merck Index, Tenth Edition, Merck and Co., Inc., 1983.
3. "NIOSH Pocket Guide to Chemical Hazards:, U.S. Department of Health and Human Services, Washington, D.C., 1985.
4. Sax, I., "Dangerous Properties of Industrial Materials", Van Nostrand Reinhold Co., New York, 1984.
5. U.S. EPA "Superfund Public Health Evaluation Manual", 1986.
6. Verschueren, K. "Handbook of Environmental Data on Organic Chemicals", 2nd Ed., Van Nostrand Reinhold Co., New York, 1983.

TABLE 2

PRECIPITATION AT NEWHALL CALIFORNIA 1951 THROUGH 1989

BERMITE DIVISION, WHITTAKER CORPORATION

YEAR	INCHES PRECIP.	YEAR	INCHES PRECIP.
1951	12.42	1971	13.75
1952	34.19	1972	4.15
1953	4.88	1973	19.79
1954	15.82	1974	18.04
1955	13.91	1975	10.92
1956	14.21	1976	14.02
1957	22.85	1977	20.87
1958	23.14	1978	42.17
1959	9.81	1979	21.47
1960	11.64	1980	25.13
1961	8.82	1981	13.65
1962	21.22	1982	20.20
1963	12.79	1983	39.07
1964	10.09	1984	12.86
1965	32.28	1985	8.37
1966	14.57	1986	18.02
1967	23.23	1987	14.45
1968	6.90	1988	16.92
1969	32.42	1989	7.27
1970	23.19		

	INCHES PECIP.	YEAR
HIGH	42.17	1978
LOW	4.15	1972
AVERAGE	17.68	

NOTE:

Precipitation Data from Newhall Soledad Station, Newhall CA
Station No. 04066162
Latitude: 34 23' Longitude: 118 32'
Elevation: 1243 feet (NGVD)

Data Obtained from:
National Climatic Data Center
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

TABLE 3

STRATIGRAPHIC CHART, SOUTHEASTERN VENTURA BASIN

BERMITE DIVISION, WHITTAKER CORPORATION

Formation/Unit	Age	Thickness (feet)	Environment/Lithology
Alluvial Deposits	Holocene	0-200	CONTINENTAL: Poorly sorted sand, gravel, boulders, and cobbles
Alluvial Terraces	Upper Pleistocene	0-200	CONTINENTAL: Poorly sorted sand, gravel, boulders, and cobbles
Saugus Formation	Upper Pliocene-Lower Pleistocene	4000-7500	CONTINENTAL-BRACKISH-SHALLOW MARINE: lenticular-poorly bedded, light, buff, poorly sorted conglomerates and sandstones with interbedded siltstone and claystone
Pico Formation	Pliocene	1000-5000	CONTINENTAL-SHALLOW MARINE: olive-gray to bluish-gray siltstone with limonitic concretions, sandstone, conglomerate
Towsley	Miocene	300-1500	MARINE: light colored lenticular sandstones with graded bedding, conglomerate, and mudstone
Modelo*	Miocene	1700-6000	MARINE: interstratified sandstones, conglomerates, and shales
Mint Canyon	Miocene	2400-4000	CONTINENTAL: lenticular conglomerate and arkosic sandstone, thin-bedded gray and green siltstone and claystone, tuff beds

*not present in subsurface east of Newhall-Saugus overlapped by the Saugus Formation

TABLE 4

SUMMARY OF OIL FIELDS AND PRODUCTION ZONES
IN THE NEWHALL-SAUGUS VICINITY*

BERMITE DIVISION, WHITTAKER CORPORATION

Oil Field	Shallowest Producing Formation	Average Depth of Shallowest Producing Oil Reservoir (feet)
Bouquet Canyon (abondoned)	Mint Canyon	2340
Castaic Hills	Saugus (basal sands)	4000
Castaic Junction	Modelo-Towsley	8400
Charlie Canyon (abandoned)	Saugus (basal sands)	600
Honor Rancho (main area)	Modelo-Towsley	3800
Honor Rancho (southeast area)	Modelo	10,000
Lyon Canyon	Modelo	9100
Newhall (Tunnel area)	Upper Towsley-Pico	600
Newhall (Townsite area)	Modelo	2700
Newhall-Potrero	Modelo	6500
Placerita	Upper Pico-basal Saugus sands	600
Saugus	Modelo	9500
Tapia	Upper Pico-basal Saugus sands	1000
Wayside Canyon	Upper Pico-basal Saugus	1500

* Adapted from Slade (1988) Table 3

TABLE 5

PHYSICAL CHARACTERISTICS OF NEAR-SURFACE VADOSE ZONE SOILS

BERMITE DIVISION, WHITTAKER CORPORATION

Sample Location	Depth (feet)	Percent Passing Individual Sieve 3/4"	1/2"	3/8"	#4	#10	#20	#40	#100	#200
BH-6	70.0- 70.5			95	84	67	48	31	15	9
BH-10	19.0- 19.5		96	93	90	82	66	49	28	19
BH-13	65.5- 66.0	100	95	93	78	59	38	25	14	9
BH-13	35.0- 35.5			100	97	82	52	33	17	12
BH-14	130.0-130.5			100	79	67	57	50	38	27
BH-6	11.5- 12.0				100	97	89	76	51	37
BH-6	40.0- 40.5	100	94	94	92	85	77	69	45	33
BH-7	20.5- 21.0				100	99	95	86	57	41
BH-12	7.5- 8.0				100	97	91	81	80	64
BH-13	110. -110.5	100	79	74	69	59	46	33	18	12

Sample Location	Depth (feet)	Liquid Limit	Plasticity Index	Unified Soil Classification
BH-13	65.5 - 66.0	--	Nonplastic	SW - SM
BH-6	11.5 - 12.0	37	17	SC
BH-6	40.0 - 40.5	30	7	SM
BH-7	20.5 - 21.0	32	11	SC
BH-10	19.0 - 19.5	27	7	SM-SC
BH-12	7.5 - 8.0	Insufficient material for plasticity index test		
BH-13	35.0 - 35.5	27	3	SW-SM
BH-13	110.0 -110.5	23	3	SP-SM
BH-14	130.0 -130.5	29	11	SC
BH-6	70.0 - 70.5	Insufficient material for plasticity index test		

Sample Location	Depth (feet)	Density (pcf)	Moisture (percent)	Permeability (centimeters/second)
BH-6	70.0 - 70.5	89.2	6.6	1×10^{-3}
BH-6	11.5 - 12.0	107.5	16.9	7×10^{-8}
BH-6	40.0 - 40.5	117.7	10.5	3×10^{-7}
BH-7	20.5 - 21.0	112.3	13.9	3×10^{-7}
BH-10	19.0 - 19.5	120.3	11.2	2×10^{-7}
BH-13	35.0 - 35.5	84.5	7.1	6×10^{-4}
BH-13	65.5 - 66.0	98.0	6.1	1×10^{-3}
BH-13	110.0 - 110.5	89.3	23.2	6×10^{-4}
BH-14	130.0 - 130.5	87.7	5.8	1×10^{-3}
BH-12	7.5 - 8.0	120.0	12.0	3×10^{-8}

TABLE 6

SOIL BORING LOG OF VAPOR PROBE NEST P-5

BERMITE DIVISION, WHITTAKER CORPORATION

Depth*	Sample Type	Lithology
0-60	cuttings	Sands and gravel, with some some clay lenses
60-61.5	SS	Clay, with sandy clay
60-86	cuttings	Clay
86-97	cuttings	Sand and gravel
97-102	cuttings	Clay, sandy
102-125	cuttings	Clay, sandy
125-139	cuttings	Sand
140-160	cuttings	Sand, with trace of clay and gravel
160-164	cuttings	Sand
164-168	cuttings	Clay, sandy and moist
168-175	cuttings	Clay, with clean sand at 170 feet
175-185	cuttings	Sand, with some gravel
185-223	cuttings	Sand and gravel

NOTE:

SS = Split-Spoon Sampler

Data Collected: April 17-20, 1989

* Elevation of ground surface in excavation = 1475 feet NGVD

TABLE 7

ELEVATIONS OF GROUNDWATER MONITORING WELLS AT BERMITE FACILITY

BERMITE DIVISION, WHITTAKER CORPORATION

WELL	WELL COORDINATES: NORTHING	EASTING	ELEVATION OF T.O.C. (FT)	ELEVATION OF GROUND (FT)	ELEVATION OF T.O.S. (FT)	ELEVATION OF B.O.S. (FT)
MW-1	3937.0208	13858.4889	1561.32	1558.0	920	900
MW-2	3498.2255	12409.7385	1424.17	1422.0	964	944
MW-3	3332.4837	13420.1627	1538.51	1535.5	860	840
MW-4	4057.4528	13416.5150	1538.43	1535.0	858	838
MW-5	4223.9131	13225.1533	1493.37	1490.5	860	840
MW-6	4363.1771	13384.0940	1521.09	1518.4	860	840
PW-1	4058.7189	13492.8914	1510.00	1510.0	865	815

NOTE:

ALL ELEVATIONS REFERENCED TO NATIONAL GEODETIC VERTICAL DATUM
T.O.C. - TOP OF CASING
T.O.S. - TOP OF SCREEN
B.O.S. - BOTTOM OF SCREEN

TABLE 8

Summary of Transmissivity and Storage Coefficients for Saugus Aquifer

Bermite Division, Whittaker Corporation

Source	Pumping Well	Well Monitored	Data Type	Transmissivity (1) (gpd/ft)	Storage Coefficient
Slade (Feb. 1988)	NC-7	NC-7	Drawdown	33300	
	NC-7	NC-7	Recovery	20700	
	NC-10	NC-10	Drawdown	31000	
	NC-10	NC-12	Drawdown	57500	0.00087
	NC-10	NC-10	Recovery	35300	
	NC-10	NC-12	Recovery	59300	0.00080
	NC-9	NC-9	Drawdown	4100	
	NC-9	NC-9	Recovery	3300	
	V-160	V-160	Drawdown	169000	
	V-160	V-160	Recovery	157000	
	V-157	V-157	Recovery	88900	
				Range: 3300-169000	
USGS (Feb. 1972)			(2)	Range: 2000-200000	0.0025
W.A.I. (Sept. 1989)	PW-1	PW-1	Recovery	24000	
	PW-1	MW-4	Drawdown	25000	0.0014
	PW-1	MW-4	Recovery	31000	0.0001
W.A.I. (Aug. 1988)	MW-4	MW-4	Drawdown	3300	
W.A.I. (Mar. 1988)	MW-1	MW-1	Drawdown	970	
	MW-2	MW-2	Drawdown	2500	
				Range: 970-31000	
USGS (Feb. 1972)			(2)	Range: 2000-50000	

(1) Transmissivities were calculated by the graphical semi-log method.

(2) Data was developed through a model which correlated aquifer parameters and electric logs from oil wells in the region.

FIGURES

WTP/A0330.DWG
3/20/90

WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS

PROJECT HYDROGEOLOGICAL ASSESSMENT

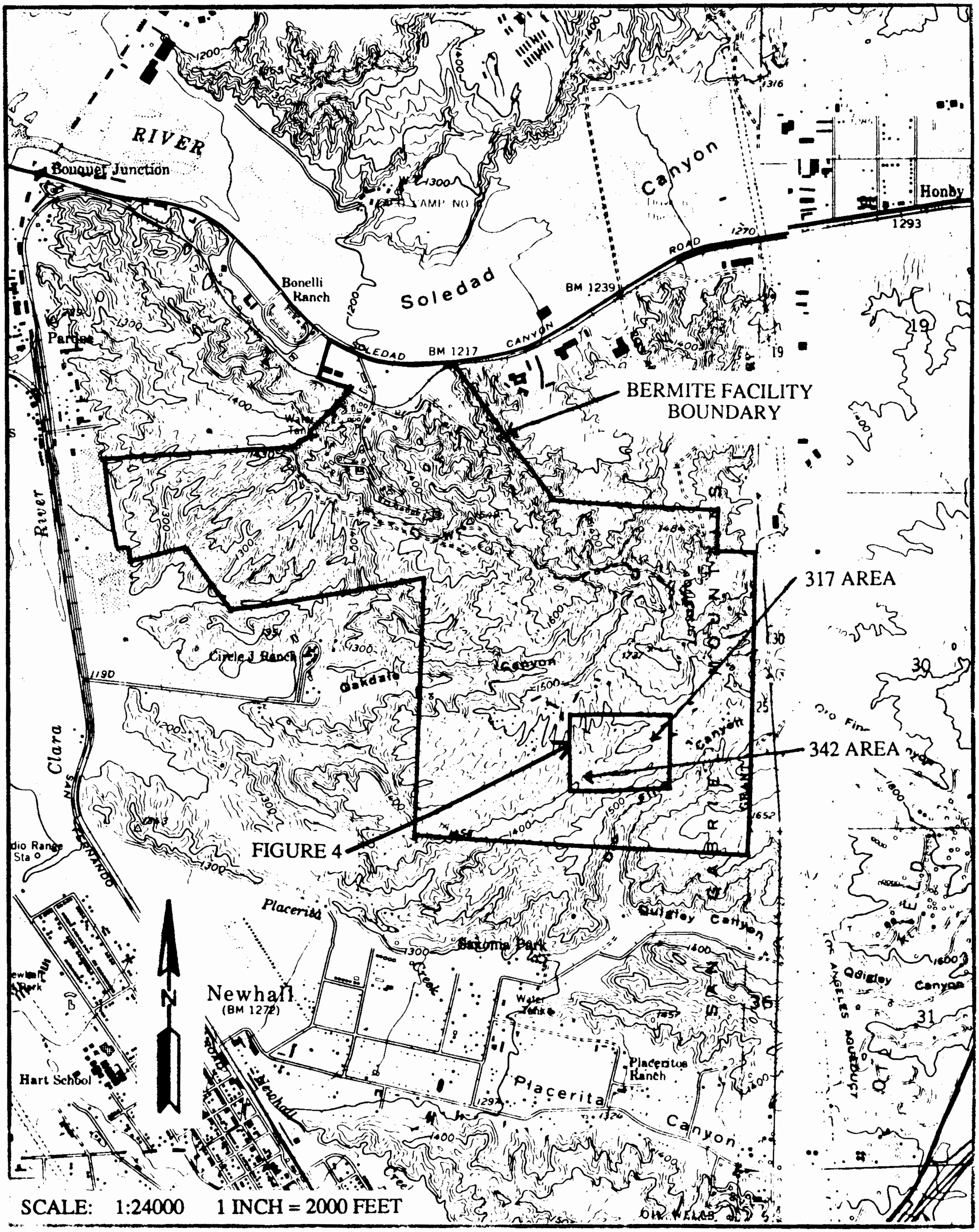
BERMITE DIVISION
WHITTAKER CORPORATION
SAUGUS, CALIFORNIA

FIGURE TITLE VICINITY MAP

DATE: MARCH 1990

REVISIONS DATE

FIGURE NO. 1



WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS
1800 Pioneer Creek Dr.
Maple Plain, MN 55359
(612) 479-4200
FAX (612) 479-4242

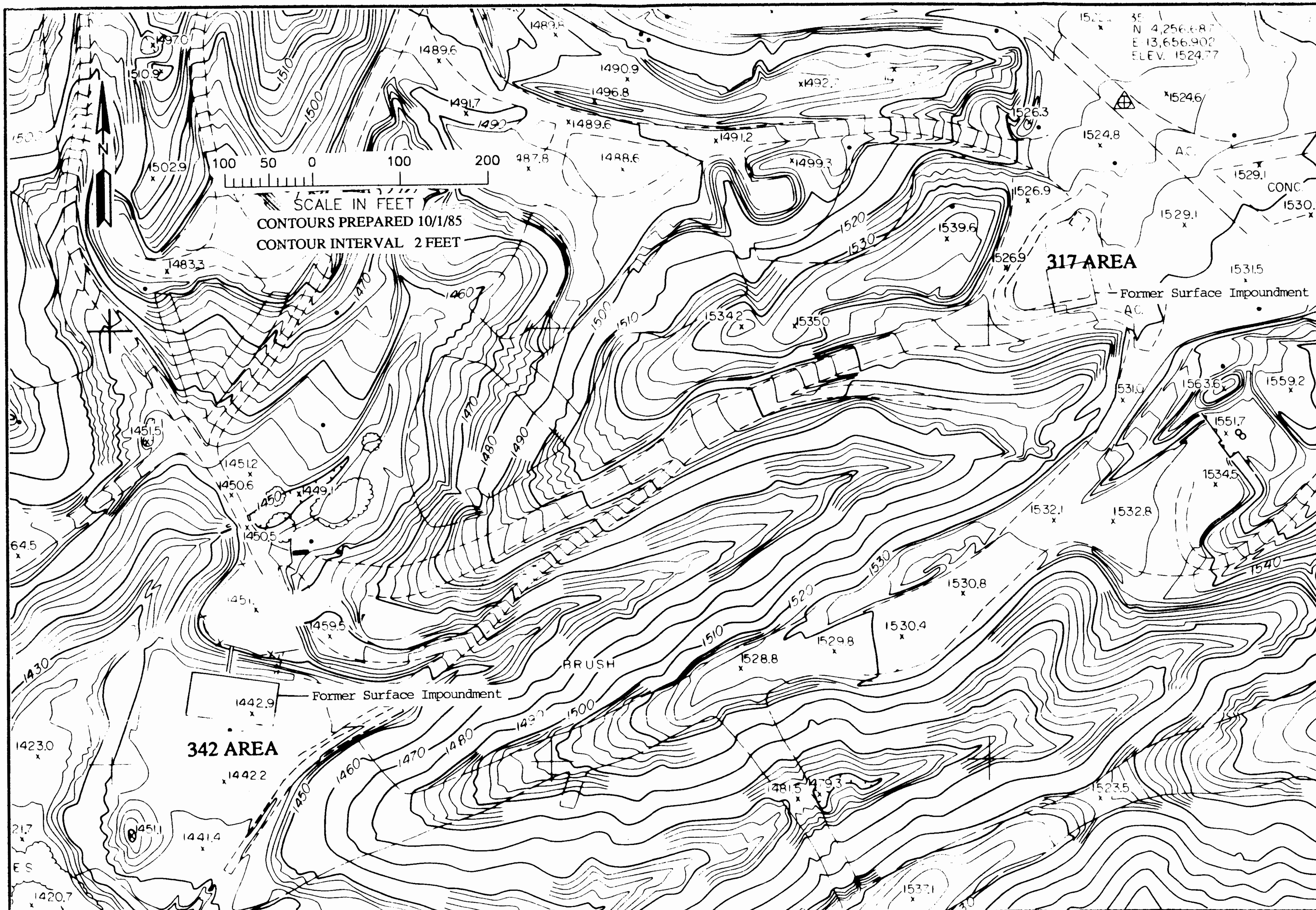
PROJECT: HYDROGEOLOGICAL ASSESSMENT
BERMITE DIVISION
WHITTAKER CORPORATION
SAUGUS, CALIFORNIA

FIGURE TITLE: SITE LOCATION MAP, BERMITE FACILITY

DATE: MARCH 1990

REVISIONS | DATE

FIGURE NO: 3

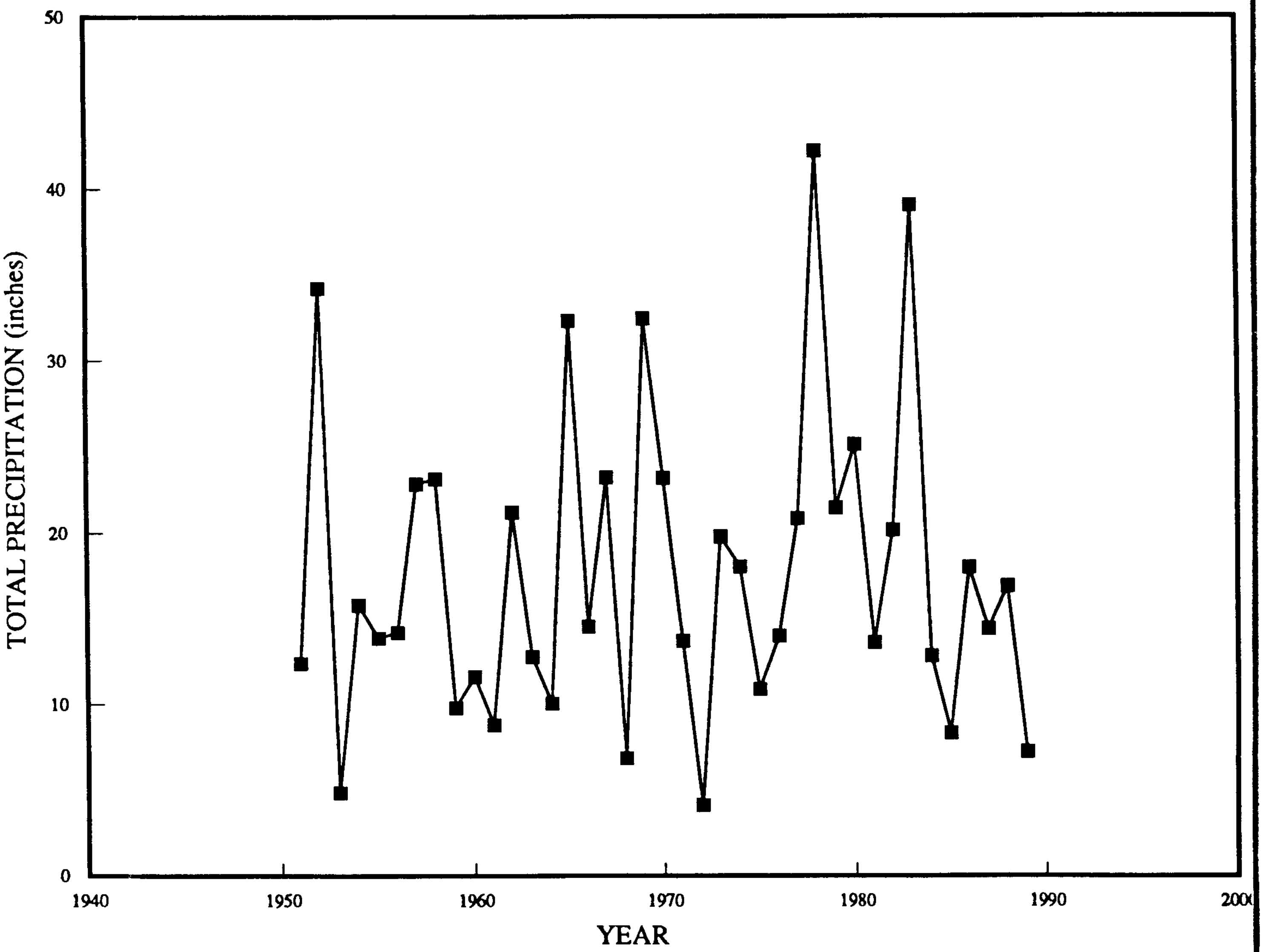


PROJECT: HYDROGEOLOGICAL ASSESSMENT

BERMITE DIVISION
WHITTAKER CORPORATION

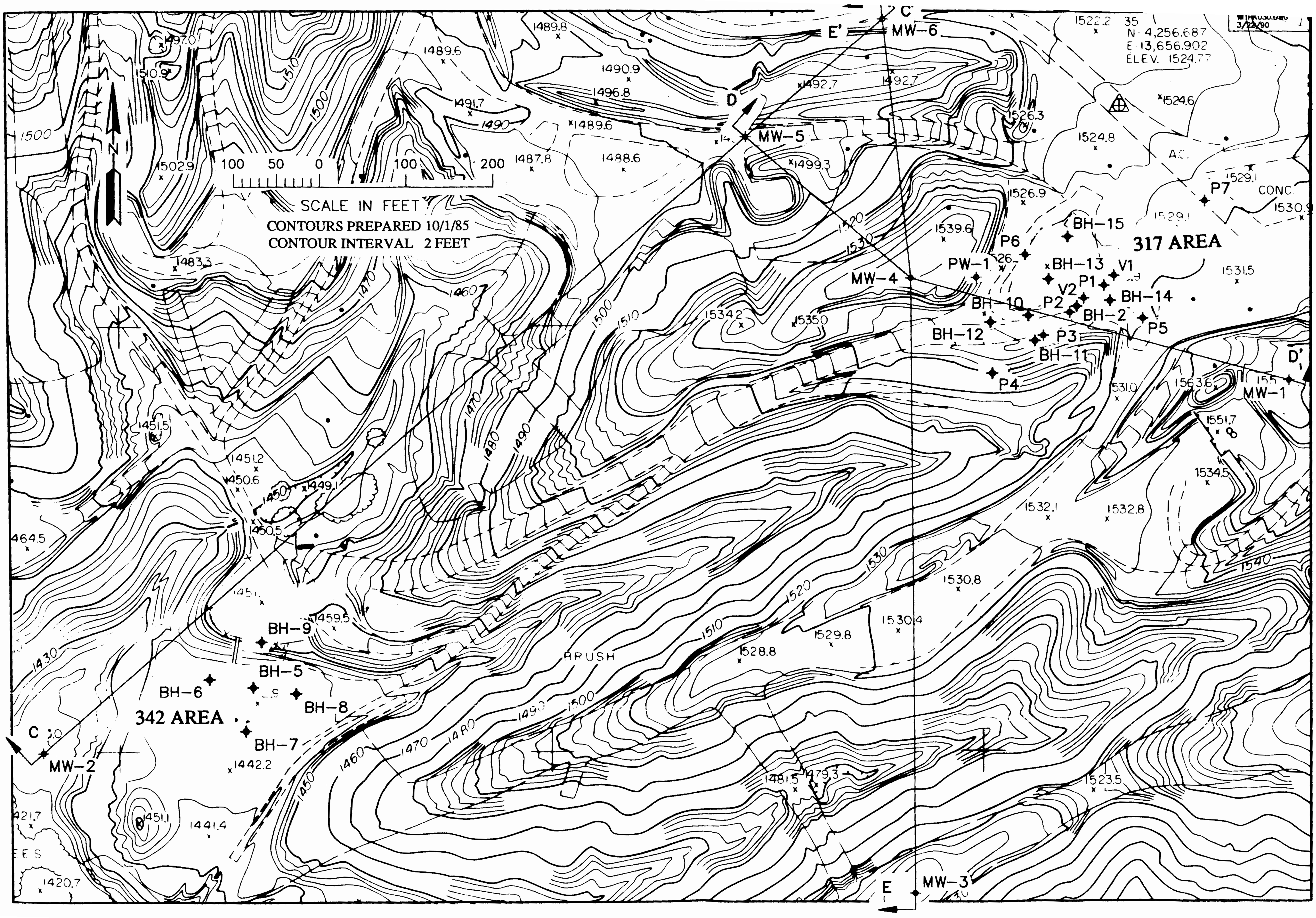
FIGURE TITLE: MAP OF 317 AND 342 AREAS

WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS



WTTEC030.DWG 3/20/90

WENCK ASSOCIATES, INC. CONSULTING ENGINEERS 1800 Pioneer Creek Dr. Maple Plain, MN 55359 (612) 479-4200 FAX-(612) 479-4242	PROJECT: HYDROGEOLOGICAL ASSESSMENT BERMITE DIVISION WHITTAKER CORPORATION SAUGUS, CALIFORNIA	FIGURE TITLE: PRECIPITATION AT NEWHALL, CALIFORNIA 1951 THRU 1989 DATE: MARCH 1990	REVISIONS / DATE	FIGURE NO. 5



PROJECT: HYDROGEOLOGICAL ASSESSMENT

BERMITE DIVISION
WHITTAKER CORPORATION
SAUGUS, CALIFORNIA

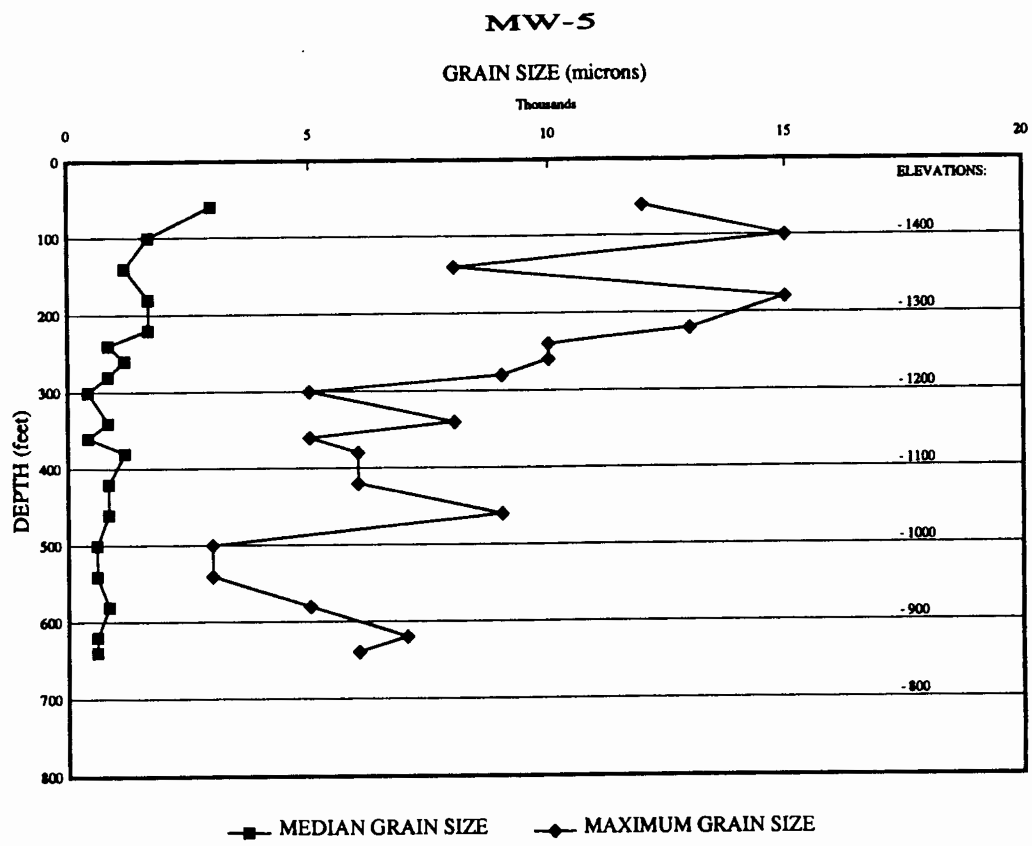
FIGURE TITLE: LOCATION OF GROUNDWATER MONITORING WELLS AND BORINGS AT THE 317 AND 342 AREAS

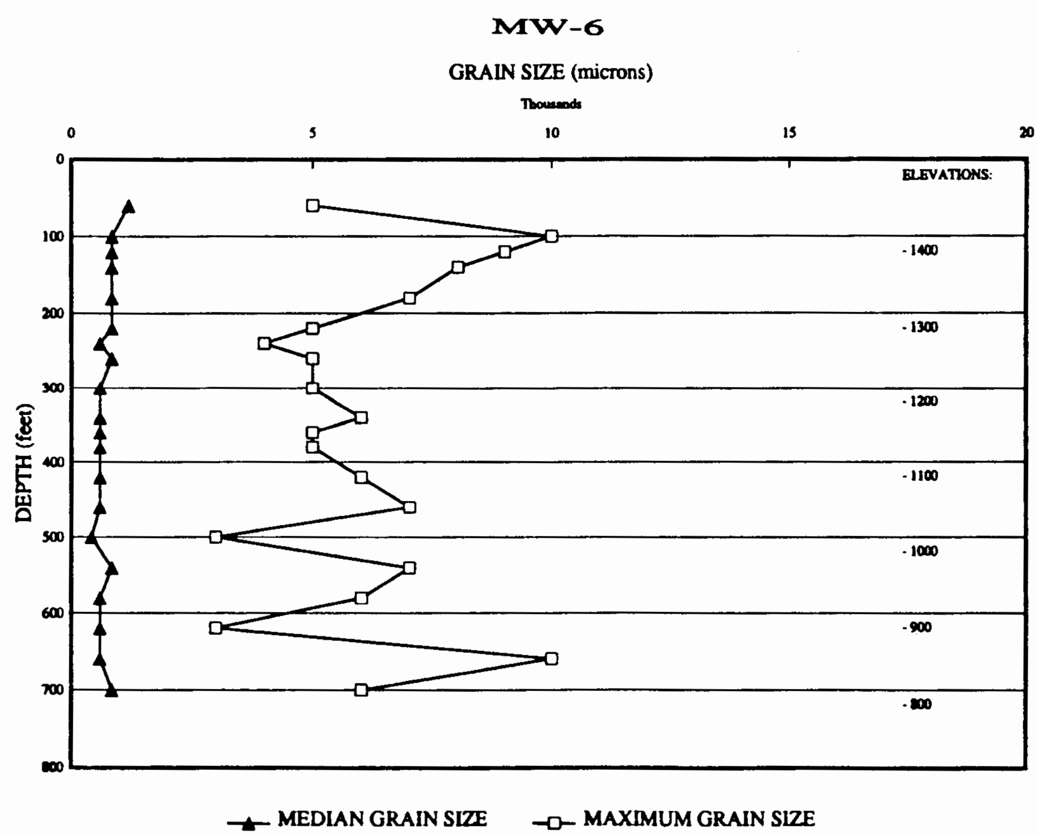
DATE: MARCH 1990

REVISIONS | DATE

FIGURE NO. 11

WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS
1800 Pioneer Creek Dr.
Maple Plain, MN 55359
(612) 479-4200
FAX-(612) 479-4242





3/20/90

WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS

PROJECT HYDROGEOLOGICAL ASSESSMENT

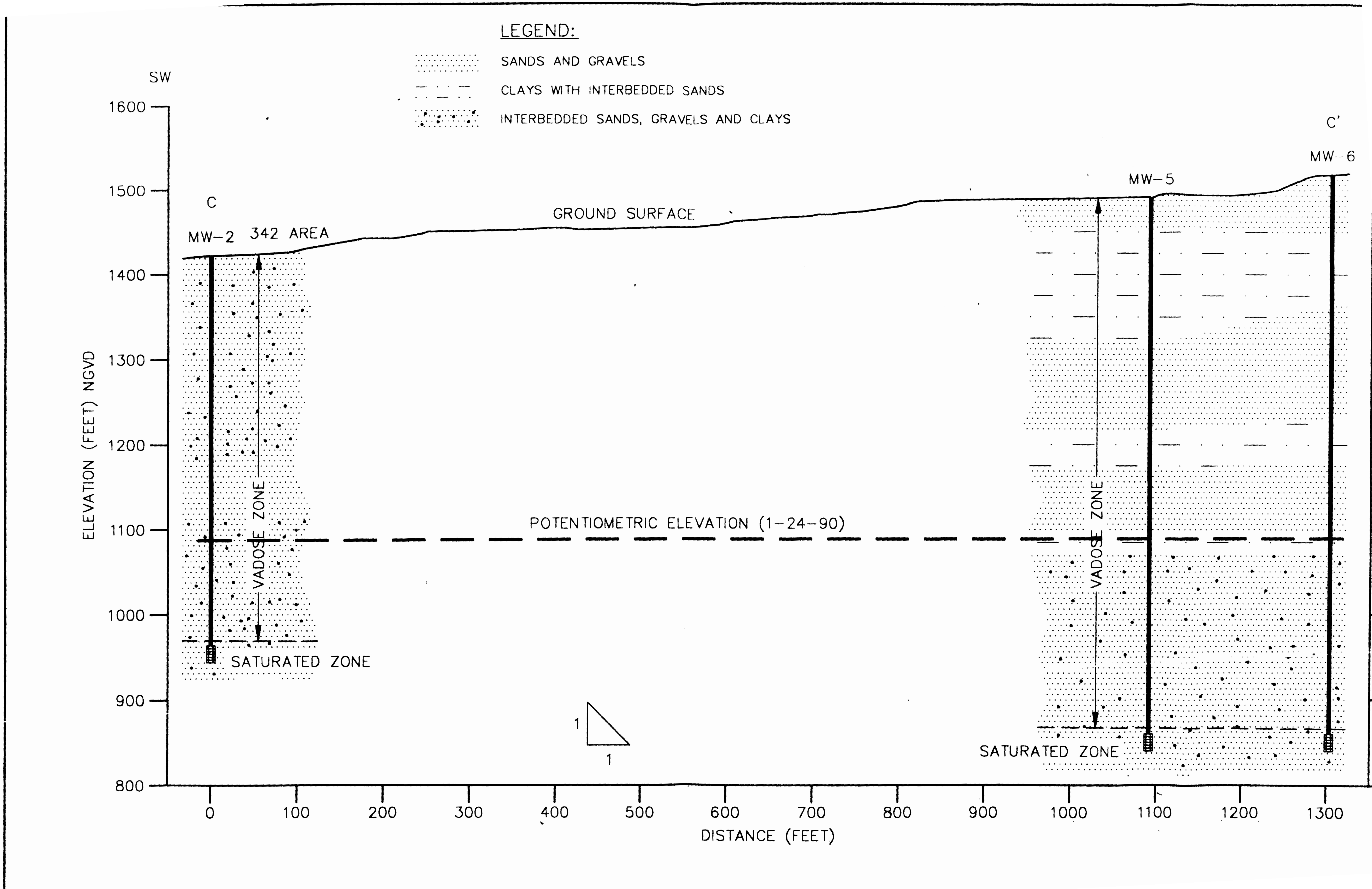
BERMITE DIVISION
WHITTAKER CORPORATION
SAUGUS, CALIFORNIA

FIGURE TITLE
VERTICAL GRAIN SIZE PROFILE FROM MW-5 AND MW-6 CUTTINGS

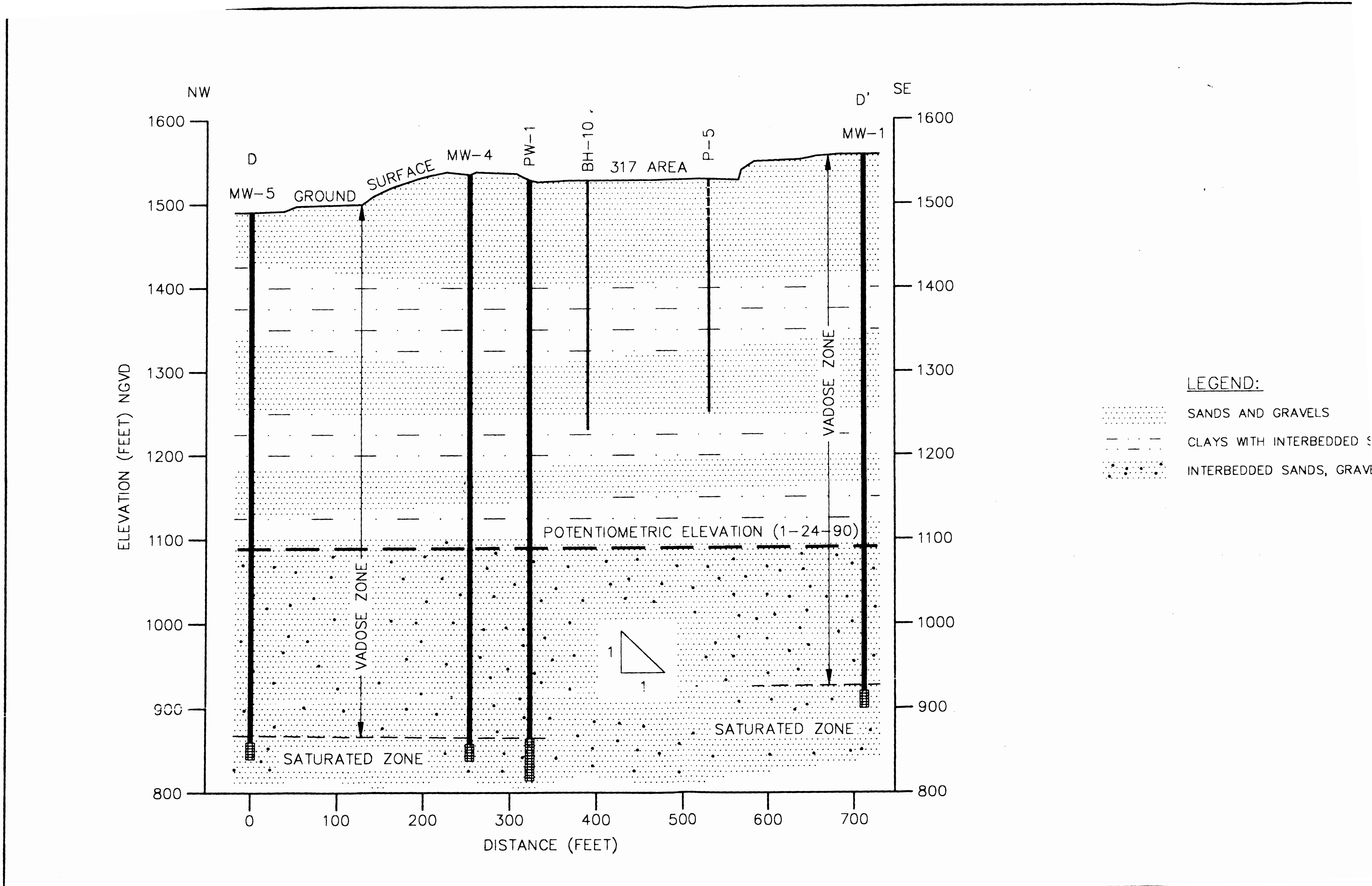
DATE: MARCH 1990

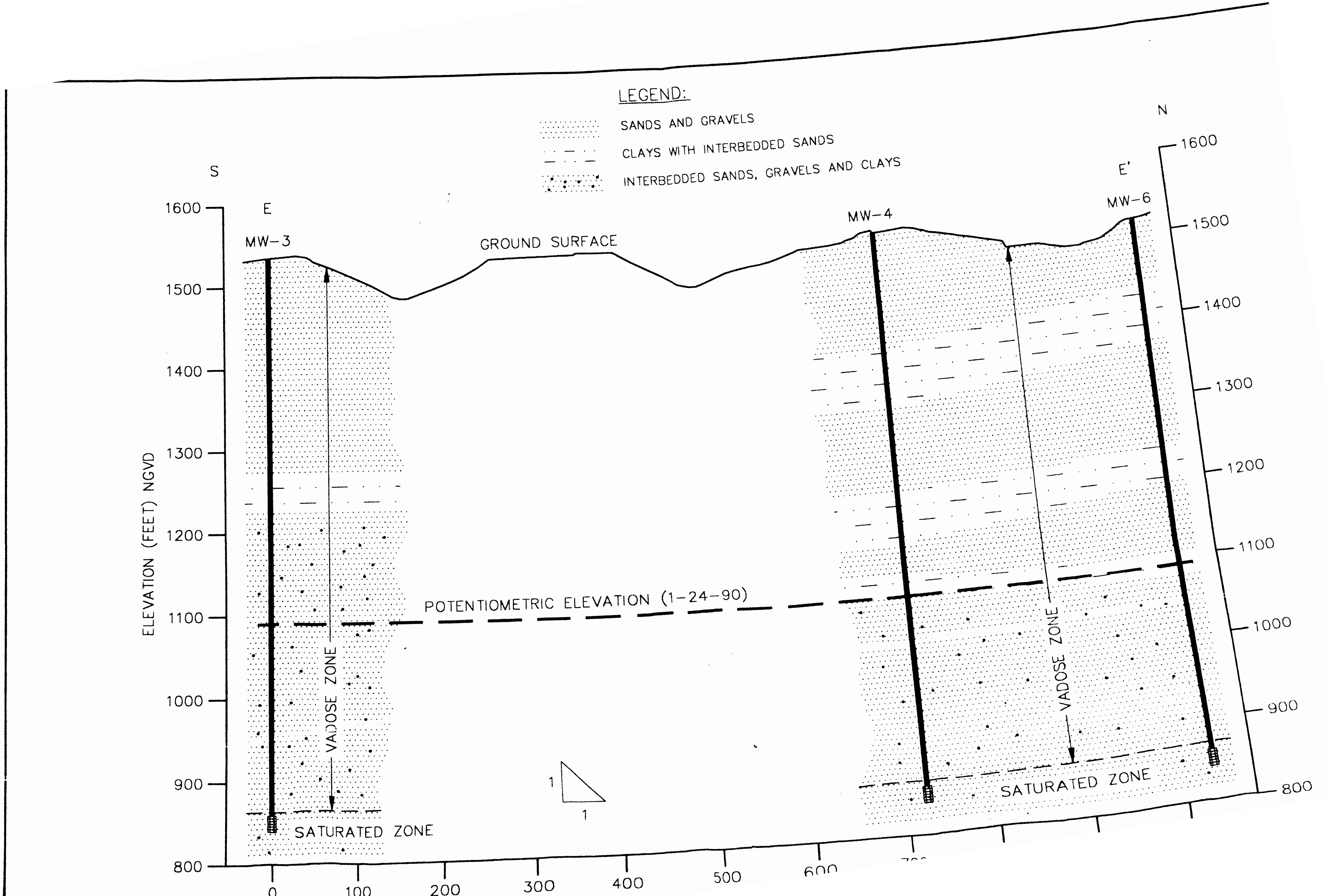
REVISIONS DATE

FIGURE NO. 15

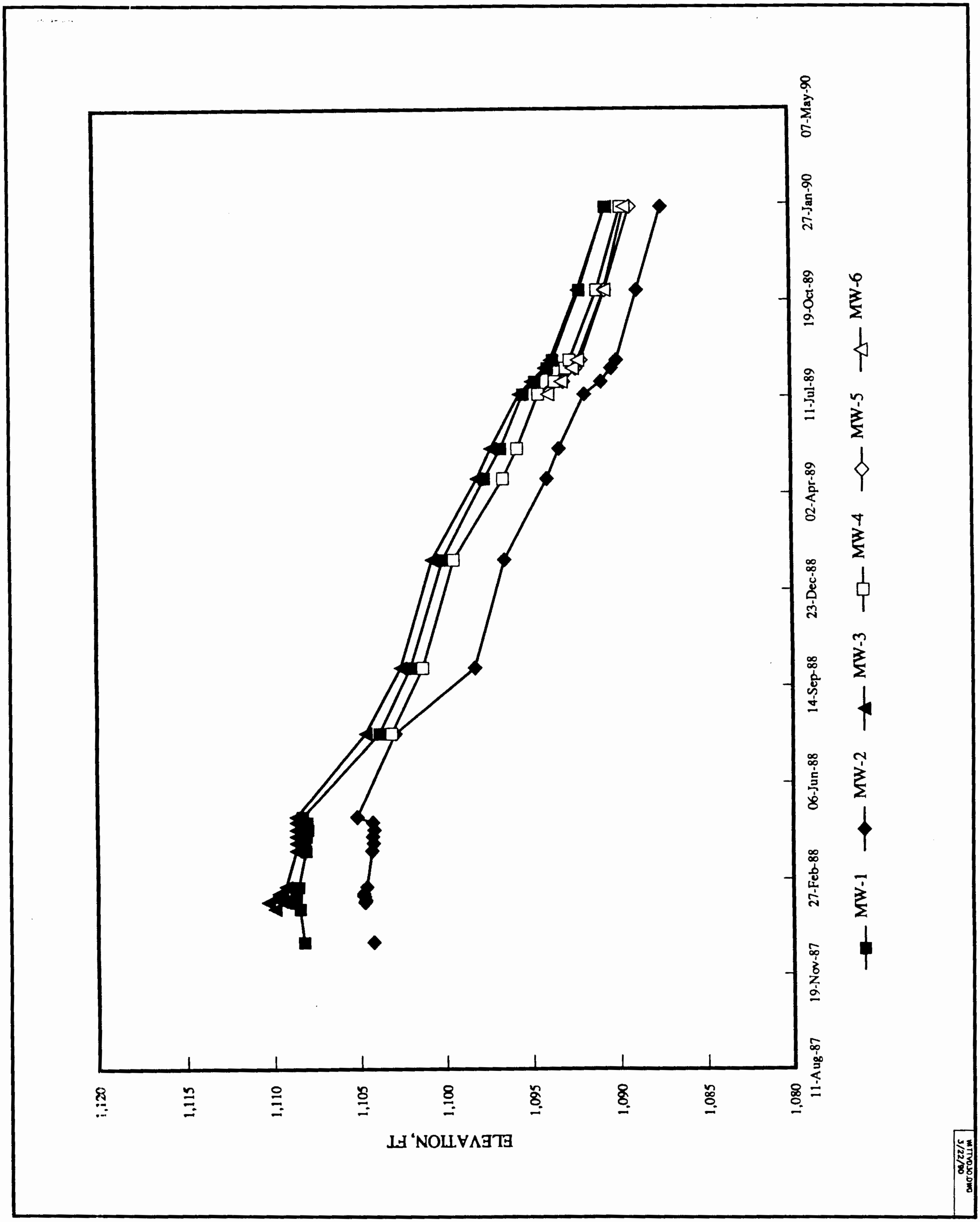


LEGEND:
SANDS AND GRAVELS
CLAYS WITH INTERBEDDED SANDS
INTERBEDDED SANDS, GRAVELS AND CLAYS
SW
C
C'
MW-2
342 AREA
MW-5
MW-6
GROUND SURFACE
VADOSE ZONE
POTENTIOMETRIC ELEVATION (1-24-90)
SATURATED ZONE
ELEVATION (FEET) NGVD
1600
1500
1400
1300
1200
1100
1000
900
800
1
1
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
DISTANCE (FEET)


NW
SE
D
D'
MW-5
GROUND SURFACE
MW-4
PW-1
BH-10
317 AREA
P-5
MW-1
VADOSE ZONE
POTENTIOMETRIC ELEVATION (1-24-90)
SATURATED ZONE
ELEVATION (FEET) NGVD
DISTANCE (FEET)
1600
1500
1400
1300
1200
1100
1000
900
800
0
100
200
300
400
500
600
700
1
1
LEGEND:
SANDS AND GRAVELS
CLAYS WITH INTERBEDDED S
INTERBEDDED SANDS, GRAVE



LEGEND:
SANDS AND GRAVELS
CLAYS WITH INTERBEDDED SANDS
INTERBEDDED SANDS, GRAVELS AND CLAYS
S
N
E
E'
MW-3
MW-4
MW-6
GROUND SURFACE
POTENTIOMETRIC ELEVATION (1-24-90)
VADOSE ZONE
SATURATED ZONE
ELEVATION (FEET) NGVD
1600
1500
1400
1300
1200
1100
1000
900
800
0
100
200
300
400
500
600



WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS
1800 Pioneer Creek Dr.
Maple Plain, MN. 55359
(612) 479-4200
FAX-(612) 479-4242

PROJECT	FIGURE TITLE	REVISIONS	DATE	FIGURE NO.
HYDROGEOLOGICAL ASSESSMENT BERMITE DIVISION WHITTAKER CORPORATION SAUGUS, CALIFORNIA	HISTORY OF POTENTIOMETRIC ELEVATIONS IN SAUGUS AQUIFER AT BERMITE FACILITY DATE: MARCH 1990			21

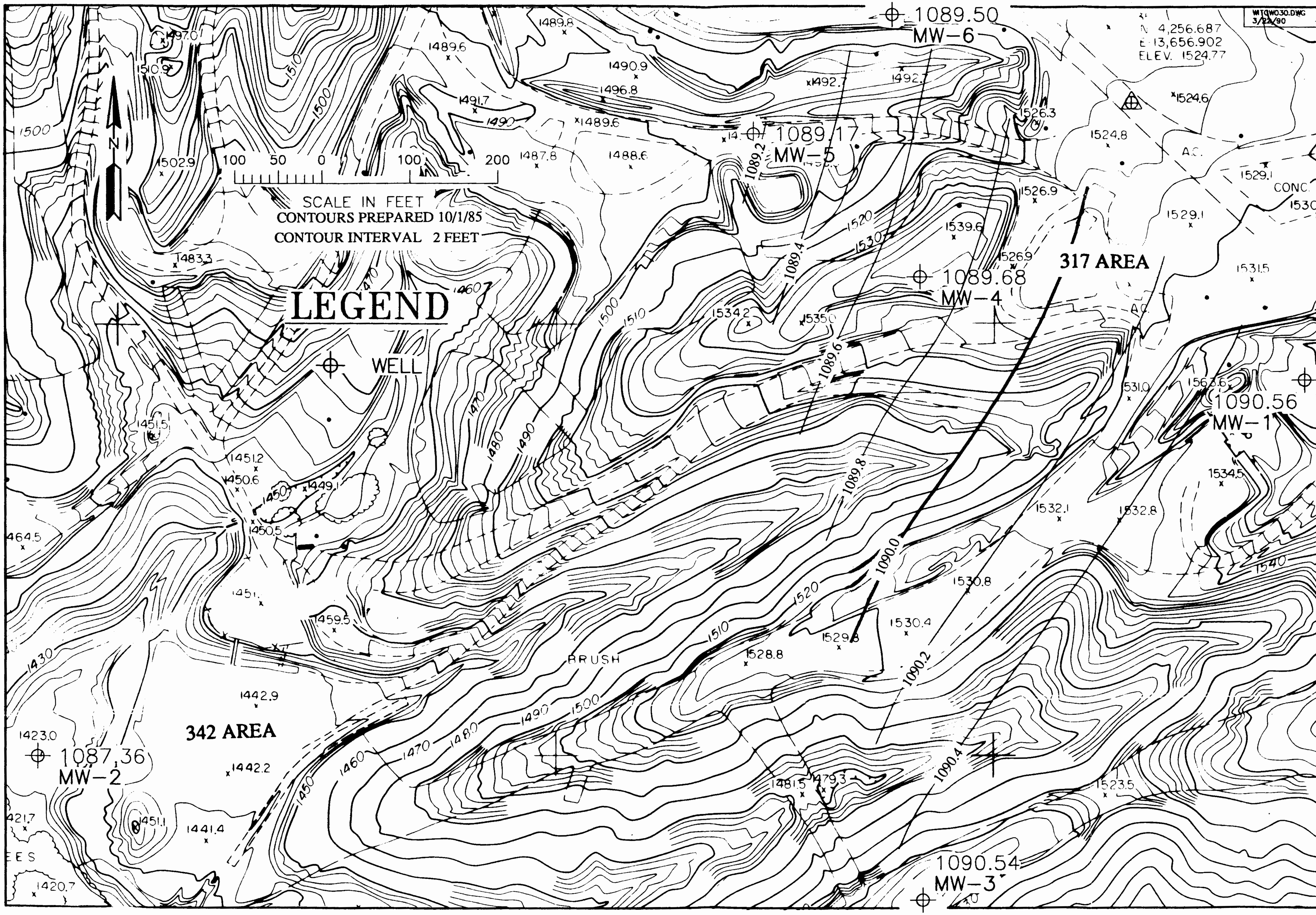


FIGURE NO. 23

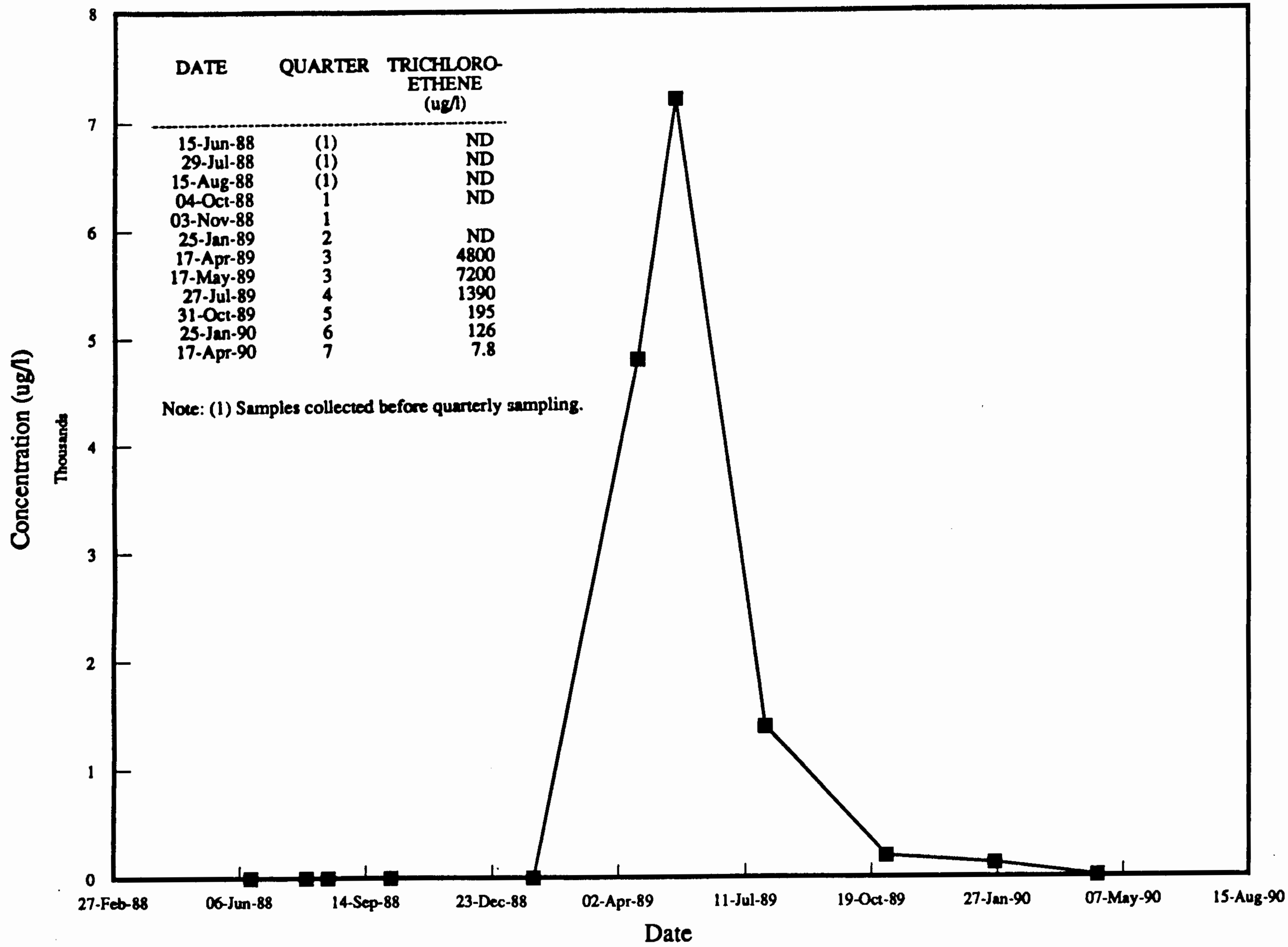
FIGURE TITLE: GROUNDWATER FLOW DIRECTION AT 317 AND 342 AREAS

DATE: MARCH 1990

PROJECT: HYDROGEOLOGICAL ASSESSMENT

BERMITE DIVISION
WHITTAKER CORPORATION
SAUGUS, CALIFORNIA

WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS
1800 Pioneer Creek Dr.
Maple Plain, MN. 55359
(612) 479-4200
FAX-(612) 479-4242



DATE	QUARTER	TRICHLORO-ETHENE (ug/l)
15-Jun-88	(1)	ND
29-Jul-88	(1)	ND
15-Aug-88	(1)	ND
04-Oct-88	1	ND
03-Nov-88	1	
25-Jan-89	2	ND
17-Apr-89	3	4800
17-May-89	3	7200
27-Jul-89	4	1390
31-Oct-89	5	195
25-Jan-90	6	126
17-Apr-90	7	7.8

Note: (1) Samples collected before quarterly sampling.

WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS

PROJECT
HYDROGEOLOGICAL ASSESSMENT
BERMITE DIVISION
WHITTAKER CORPORATION
SAUGUS, CALIFORNIA

FIGURE TITLE
TCE CONCENTRATION
IN WELL MW-4

DATE: MAY 1990

REVISIONS

DATE

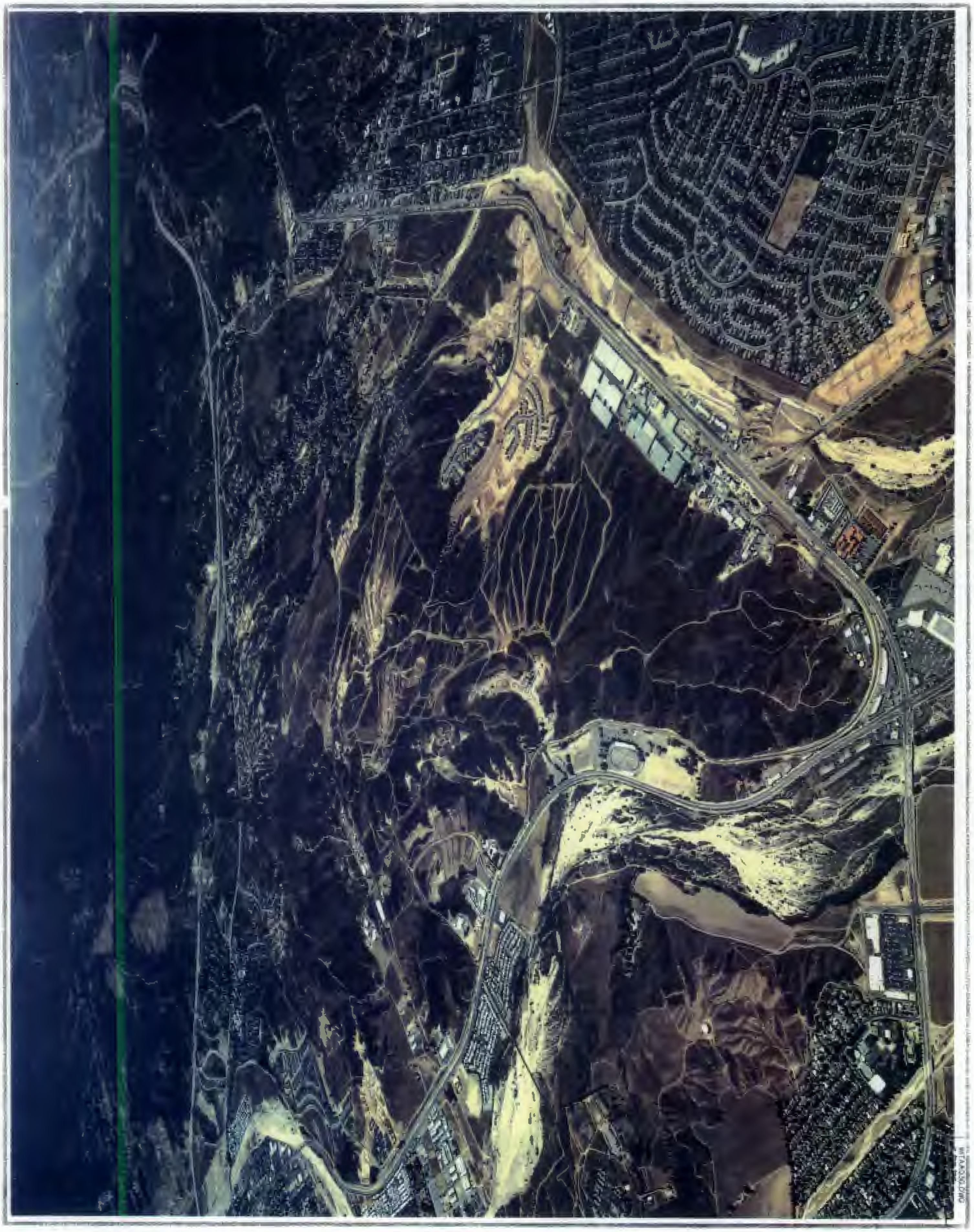
FIGURE NO.
24

WTTXO5O.DWG
5/17/90

APPENDICES

APPENDIX A

SITE AERIAL PHOTOGRAPHS (5/2/87)



WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS

PROJECT HYDROGEOLOGICAL ASSESSMENT

BERMITE DIVISION
WHITTAKER CORPORATION

FIGURE TITLE VIEW LOOKING SE

REVISIONS DATE

FIGURE NO.

WENCK ASSOCIATES, INC.
CONSULTING ENGINEERS
1800 Pioneer Creek Dr.
Maple Plain, MN. 55359

PROJECT HYDROGEOLOGICAL ASSESSMENT

BERMITE DIVISION
WHITTAKER CORPORATION

FIGURE TITLE VIEW LOOKING NW

DATE MARCH 1990

REVISIONS DATE

FIGURE NO.

APPENDIX B

PIONEER CONSULTANTS

REPORT AND BORING LOGS (JULY 1987)

pioneer consultants
251 TENNESSEE STREET • REDLANDS, CALIFORNIA 92373 • (714) 793-2691

J.N. 4257-001
July 28, 1987

Wenck Associates Inc.
832 Twelve Oaks Center
15500 Wayzata Boulevard
Wayzata, Minnesota 55391

PRELIMINARY
NOT APPROVED

Attention: Mr. Norman C. Wenck, P.E.
President

Re: Subsurface Investigative Program
Whittaker Corp. Bermite Facility
Saugus, California

Subject: Update to Status Report of July 7, 1987

Gentlemen:

At the request of Mr. Norman Wenck, we are presenting for review a second interim status report which addresses those activities which have occurred at the referenced project since July 7, 1987. These activities specifically include the following:

1. The completion of a 2-inch PVC monitoring well to 301 feet at boring BH-10, Area 317;

2. Completion of BH-15, Area 317;

3. Submittal of chemical analyses received from project to date;

4. Tentative conclusions and recommendations drawn from data available to date;

ENCLOSURE 1

PRELIMINARY
NOT APPROVED

EXECUTIVE SUMMARY

Field Activities

The subsurface investigation conducted at Area 317 consisted of drilling ten exploratory borings to depths ranging from 9 to 301 feet below the ground surface. The Site Plan for Area 317 is presented as Exhibit 1. Nine of these borings were completed prior to July 7, 1987 with one additional boring completed since that date. Boring advancement was by hollow-stem rotary flight auger in the first four borings with conversion to rotary air methods with foam injection within the remaining six upon refusal of the hollow-stem auger.

With regard to Area 342, no additional subsurface borings have been conducted since submittal of the status report of July 7, 1987. The Site Plan for Area 342 is presented on Exhibit 2. However, a preliminary sample of the water collected within the lower portion of the monitoring well before development has now been analyzed within the selected laboratory. Recent measurements indicate no free groundwater is present within the well casing to its total depth.

The monitoring well now established in Area 317 to a total depth of 301 feet has been completed. Recent measurements indicate no free groundwater is present within the well casing to its total depth.

PRELIMINARY
NOT APPROVED

The additional soil boring drilled at Area 317 (identified as BH-15) was advanced to a total depth of 101.5 feet. Within this boring, the measurements of the volatile organic vapors were in the range of 1 to 30 parts per million. No distinct intervals or measurable high concentrations were identified at the time of drilling.

Cross sections have been developed for Areas 317 and 342. These sections are included as Exhibits 3 through 5. Identified on these cross sections are the chemical analysis data and the field measurements obtained with either an h.nμ photoionization detector or a Foxboro OVA. Additionally, correlations between borings and material types are indicated where information is'sufficient to make appropriate distinctions.

Results

The chemical analyses obtained from the borings conducted in Area 317 indicate essentially nondetectable concentrations of purgeable organic contaminants to the detection levels indicated. Three exceptions have been identified: (1) within BH-14 at a depth of 40.5 to 41.0 feet, 1,3 transdicloropropane was identified at a concentration 12 parts per billion (ppb); (2) within BH-14 at a depth of 70.5 to 71.0 feet, a 24 concentration of trichloroethane was identified; (3) within BH-14 at a depth of 5.5 to 6.0 feet, a concentration of 10 parts per billion of 1,2 Dichlorobenzene. Heavy metal analysis indicates that, in Area

PRELIMINARY
NOT APPROVED

317, levels essentially ranged within background values. No appreciable high concentrations were identified in the analysis conducted. pH varied consistently from 6.5 to 9.0 with only minor fluctuations.

Field instrumentation used for on-site detection did indicate, at the time of collection within certain borings, the presence of volatile organic vapors, specifically within BH-2, BH-13, and BH-14. Exact concentrations are recorded on the attached cross sections and boring logs.

In Area 342, the chemical analysis conducted on the soil samples for purgeable organics identified that all contaminants were in the nondetectable range to the detection levels indicated. The analysis for the RCRA metals indicated no distinct high levels, indicating no metals above anticipated background levels. The pH of the samples analyzed was consistently within the range of 6.5 to 9.0 with an average of 7.5 to 8.0. The presence of phosphorus was detected in one boring only (BH-6 at a depth of 60.0 to 60.5 feet) at a concentration of 13 parts per million, approximately double the detection level. All other analysis indicated the presence of phosphorus in the nondetectable range.

With regard to the identified water in Area 342, the chemical analysis originally performed appeared to contain one contaminant. A second analysis of a sample of moist soil detected no components. The moisture present is minimal.

PRELIMINARY
NOT APPROVED

PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

The results of the chemical analyses to date indicate, in Area 317, some low levels of organic solvent contamination are present. The contamination appears to be occurring sporadically with all detected concentrations in the low parts per billion range. The presence of volatile organic vapors emitted from the borings and within the undisturbed soil samples collected gives additional indications that subsurface soil contamination may be present at isolated locations and depths at this site. To date, no clear-cut explanation has been developed to explain the sporadic appearances of these contaminants or the variations in the presence of organic vapors within the borings performed. This information will be further evaluated to establish an appropriate conclusion concerning the presence and extent of contaminants at this site.

With regard to Area 342, the absence of detectable, purgeable organics, consistent ranges of pH and essentially background levels of heavy metals, and the detection of one sample containing low levels of phosphorus indicate that soil contamination in the locations of the borings performed is not present. The presence of a contaminant within the identified seepage at 60.0 to 60.5 feet in BH-6 was not confirmed with a second sample collected July 27, 1987.

PRELIMINARY
NOT APPROVED

An update to the regional geology and hydrogeology statements of the site has been developed by Mr. Robert Bean. His report is included for review as Appendix A.

SUMMARY

It has been our intent with this updated interim status report to present the most recent information collected at the referenced site. A complete evaluation of all data has not yet been performed in order to finalize a report for these sites. At the time that information is compiled and a clear understanding is developed, the final report will be issued. In the meantime, it is our hope that the information provided will be sufficient for your update on this project.

Should there be any questions prior to submittal of a final report for this phase of the work, please feel free to contact this office at your convenience.

Respectfully,

PIONEER CONSULTANTS

Kyle D. Emerson, C.E.G. #1271
Vice President

KDE:ljs
Addressee (2)
Attachments

PRELIMINARY
NOT APPROVED

APPENDIX A

HYDROGEOLOGIC ASSESSMENT

The present report is a hydrogeologic assessment of conditions at the Bermite facility based on information currently available. Presently available data and information include the following:

1. Draft geologic maps by J. A. Treiman and F. H. Weber, both of the California Division of Mines and Geology.

2. Data obtained by the recent drilling program conducted by Pioneer Consultants which includes logs of fifteen bore holes and their lithologic interpretation, readings by the OVA instrument at various depths and notations with regard to groundwater. Only a trace of groundwater was found and in only one hole (BH-6).

2. The Partial Laboratory Report by West Coast Analytical Service, Inc., dated July 14, 1987 which contains analyses from the following bore holes: 2, 5, 6, 7, 8, 9 and 10. In this partial report, no organics were found above the detection limit.

3. Information available from the Bermite Division, including depth to groundwater in the producing well.

4. Information from the Newhall County Water District, Santa Clarita Water Company and Los Angeles Department of Water and Power.

5. Maps from the Los Angeles County Department of Public Works, including maps of groundwater levels in valleys adjacent to Bermite and average precipitation including the Bermite area.

6. Published and unpublished information from the California Department of Water Resources and the U.S. Geological Survey.

Geologic Conditions

The entire Bermite facility is underlain by sedimentary materials, mostly unconsolidated and uncemented to moderately indurated. The facility is crossed from northwest to southeast by the San Gabriel Fault, as shown in Exhibit A-1. Recent geologic mapping of the area has been done by Jerome A. Treiman of the California Division of Fines and Geology. F. Harold Weber of the same agency has completed a draft report on the San Gabriel Fault including the area of the Bermite facility. In addition, with the cooperation of Bermite personnel, he and coworkers have opened trenches across the San Gabriel Fault in order to learn more about recency of fault movement, and the nature of the movement. Weber's latest map was utilized in preparing Exhibit A-1.

PRELIMINARY
NOT APPROVED

Formations: The Bermite facility is underlain principally by two sedimentary formations. The younger of these has generally been called terrace deposits; although both Treiman and Weber call most of these materials "Pacoima(?) formation".

The terrace deposits range from clay to gravel and boulders. Clayey sand is most common in the bore holes, but gravel, cobbles and boulders make the drilling difficult. Some clean sands are present and silt occurs in many strata. The terrace deposits are Quaternary continental deposits, originally principally stream-laid. Treiman's map shows these deposits as flat-lying or nearly so. For the record, some thin, recent alluvial and colluvial deposits overlie the terrace sediments principally in stream beds and local areas of ponding, and artificial fill is present in some places.

The terrace materials form a surface blanket of varying thickness in most of the southern part of the Bermite facility, including the 317 and 342 areas. The actual contact between the terrace and the underlying Saugus formation sediments is difficult to determine, since the two are very similar lithologically. In the bore holes at the 317 area, the contact may lie generally between the clayey sands and the quartz sands, at depths of about 13 to 40 feet. This change is not as apparent at the 342 area. For purposes of this investigation, the location of this contact has little or no importance.

The Saugus formation underlies the terrace deposits at the 317 and 342 areas and vicinity southwest of the San Gabriel Fault zone. The Saugus occurs at the surface immediately southwest of the fault zone, and throughout most of the rest of the Bermite property northeast of the fault. Treiman's map describes the Saugus sediments southwest of the fault as "coarse facies) - generally moderately to well-indurated, massive to well-bedded...gray to light brown sandstone and conglomeratic (pebbly to bouldery) sandstone with scattered greenish-gray to reddish-brown siltstone and silty sandstone."

The sediments of the Saugus formation are extremely thick. The log of oil well "Circle J-2," drilled very near the western boundary of the Bermite property about 3/4 mile northwest of the 342 area reports the Saugus over 4100 feet thick.

Structure: The principal fault of the San Gabriel Fault zone extends continually through the Bermite property from northwest to southeast as shown on Exhibit A-1. Shorter subparallel breaks near the main fault area also shown and are particularly numerous in the northwest part of the property, near where the Holser Fault joins the San Gabriel from the west. The San Gabriel Fault is undoubtedly a barrier to lateral movement of groundwater, but some slow seepage of groundwater through the fault probably does occur.

The sediments of the Saugus formation near the San Gabriel Fault tend to strike approximately in the direction of the fault, according to Treiman. Dip is mostly to the south, and varies up to more than 80 degrees southwest of the fault.

In most areas where terrace (Pacoima ?) sediments have been mapped by Treiman, the stratified materials are horizontal, or dip no more than 5 degrees.

Hydrogeologic Conditions

During the rainy season, rainfall and resulting stream flow percolate into the more permeable areas of the terrace and Saugus formations in the Bermite region. Any leakage or spillage from impoundment ponds follows the same course. These waters move principally downward until they reach an impermeable or nearly impermeable zone, normally high in clay. There, the water forms a perched water body. Perched groundwater takes three courses. Part of the water seeps on downward if the perching bed has some permeability. Part of the water moves laterally according to the slope of the perching bed and the hydraulic gradient of the water body. This lateral movement may bring the groundwater to the surface in a temporary spring where the perched water reaches a ravine.

Lateral movement may also bring the perched water to the edge of the perching bed, where it will spill over and continue downward. The beds in the terrace sediments are very discontinuous and lenticular, so this type of movement is undoubtedly common.

The third course for part of the perched water is evaporation. After infiltration has ceased, some of the subsurface water goes into the vapor state. In the summer particularly, this water vapor moves upward in the air in the intergranular spaces, and eventually is discharged above the ground surface.

Any down-percolating water that is not intercepted in a perched zone or does not evaporate, eventually will reach the regional water table. Hole BH-10 at the 317 area was drilled to a depth of 300 feet, and did not reach the regional water table.

317 Area: The detailed description of the holes bored at the 317 area appears in the accompanying report by Pioneer Consultants and will not be repeated here. The materials logged in all the holes, varying from boulders to clay, are typical of the terrace sediments, underlain in the deeper holes by the Saugus formation.

No perched water has been found in the present drilling program. This is not surprising, since precipitation during the 1986-87 rainy

PRELIMINARY
NOT APPROVED

season was well below normal. The report "Water Conditions in California" for May 1, 1987, by the California Department of Water Resources, shows that average precipitation in the South Coast area, including the Santa Clara River drainage, was only 52 percent of normal during the current water year. Furthermore, the preceding year was also drier than normal.

A copy of a map showing contours of average precipitation for a 90-year period has been obtained from the Los Angeles Department of Public Works. This map shows the average precipitation at the Bermite facility to be about 17 inches.

Hydrologists generally agree that, in an area with annual precipitation in this range, the native vegetation uses all or nearly all the rainfall that does not run off or evaporate in a year of average or below average precipitation. Significant recharge to groundwater thus can occur only in years of above average rainfall. Even in such years, as described above, down-percolating recharge water tends to dissipate and evaporate before reaching a deep water table.

The water table at the 317 (and 342) areas is obviously deep, as it was not reached by BH-10 at a depth of 300 feet. The relationship of the regional water table beneath the Bermite facility, if indeed a water table in the traditional sense is present at all, to groundwater levels in adjacent valleys is illustrated by Exhibit A-2. Here the Los Angeles County Department of Public Works shows groundwater contours in both Santa Clara River Valley to the north and Placerita Creek Canyon on the south. A line drawn between the ends of the 1225-foot groundwater contours in the two valleys passes almost directly beneath Bermite's 317 area. Very interestingly, the bottom of BH-10 was almost exactly at the same elevation, 1225 feet (1525 feet to 300 feet).

The significance of the lack of a water table at 1225 feet beneath the 317 area is this: there is thus no mound of groundwater which has a lateral hydraulic gradient from the 317 area sloping either to the north or the south. In other words, no groundwater movement can occur either to the north to the Santa Clara River Valley or directly south to Placerita Creek Valley. Furthermore, the San Gabriel Fault, plus steeply dipping beds along the fault as mapped by Treiman, would effectively block movement to the Santa Clara River Valley.

If there is a water table at a lower elevation, from which groundwater could move southwesterly into lower Placerita Creek Valley, could only be ascertained with a deeper well. Such a well might not reach a saturated zone, or water table, to an elevation below 1100 feet, or below the groundwater level in lower Placerita Creek Valley and the valley of the South Fork, Santa Clara River. In such a case, no

PRELIMINARY
NOT APPROVED

groundwater could move from the Bermite 317 area to any of the surrounding valleys in which wells are located.

The only groundwater found in either the 342 or 317 areas was a trace of groundwater between 60 and 61 feet in BH-6 in the 342 area. In spite of careful attempts to develop and sample the water in this zone, it has not been possible to obtain other than a muddy sample.

This perched water is undoubtedly the result of incidental recharge that has taken place in the vicinity recently. Water has been applied to the bench just south of the level pad, largely by a leaky valve in a waterline, according to persons familiar with recent activity in the area. BH-9, on the bench, encountered damp sediments, giving additional evidence of this incidental recharge.

Water has been observed in the past, on the surface, down-valley from the 342 area. Observation of this down-valley area at present shows a fill dam, now breached, about 400 feet from the 342 area. Siltation has occurred behind the dam, and the area is now heavily vegetated.

The silted area behind the dam is presently dry, but in the past, an intermittent pond has obviously been present. Water, natural or contaminated, from the 342 area has probably percolated straight downward, and then moved down-valley on a perching bed, to reappear at the ground surface at or near the pond. Any surface water moving down the canyon would also contribute to the intermittent pond.

Conclusions

1. No deep water table or groundwater body was found beneath the 317 area, although a 300-foot hole was drilled to an elevation of about 1225 feet.

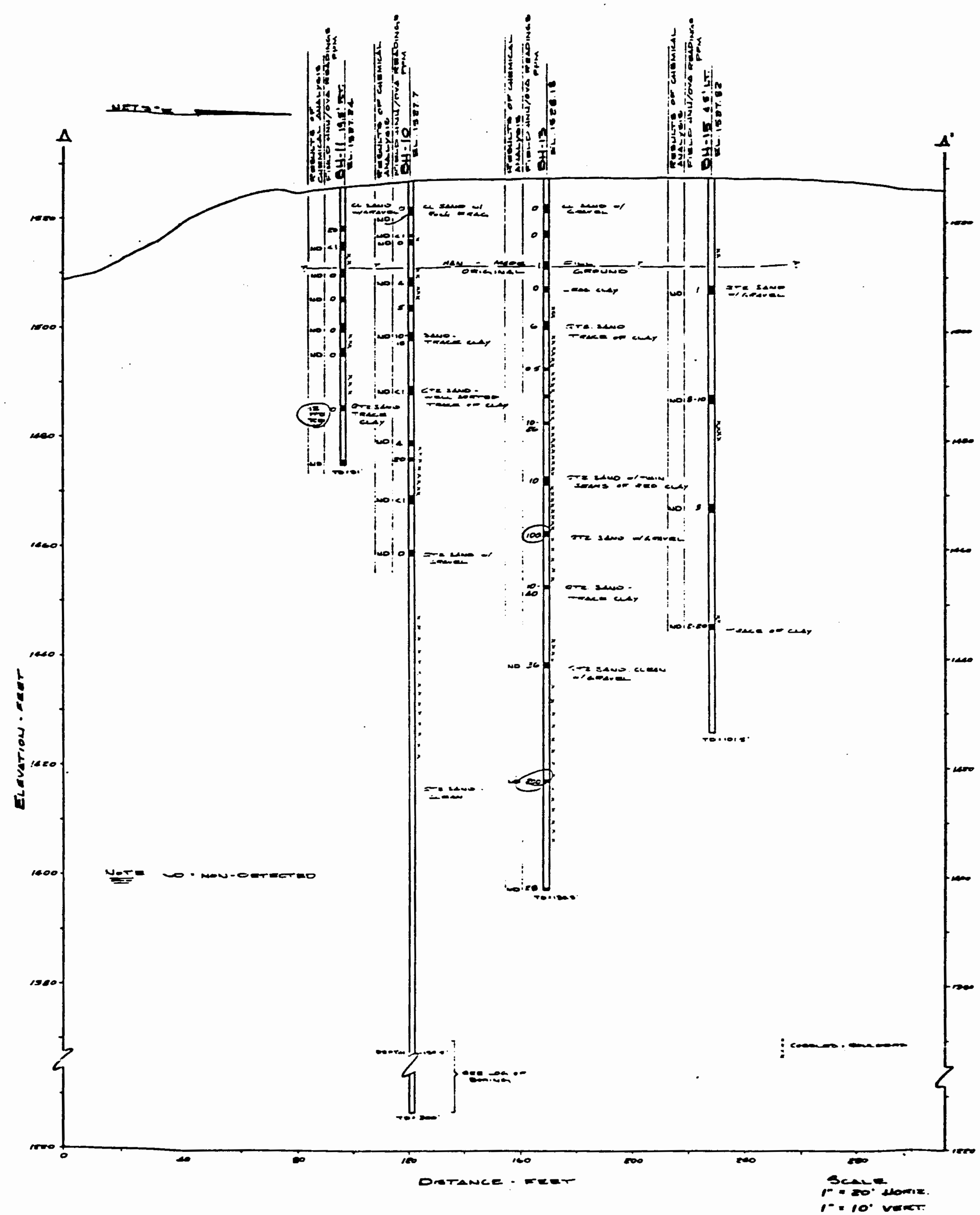
2. The elevation of 1225 feet is the same as that in both the Santa Clara River Valley on the north and Placerita Creek Valley on the south. There is thus no groundwater gradient and no movement either to the north or south.

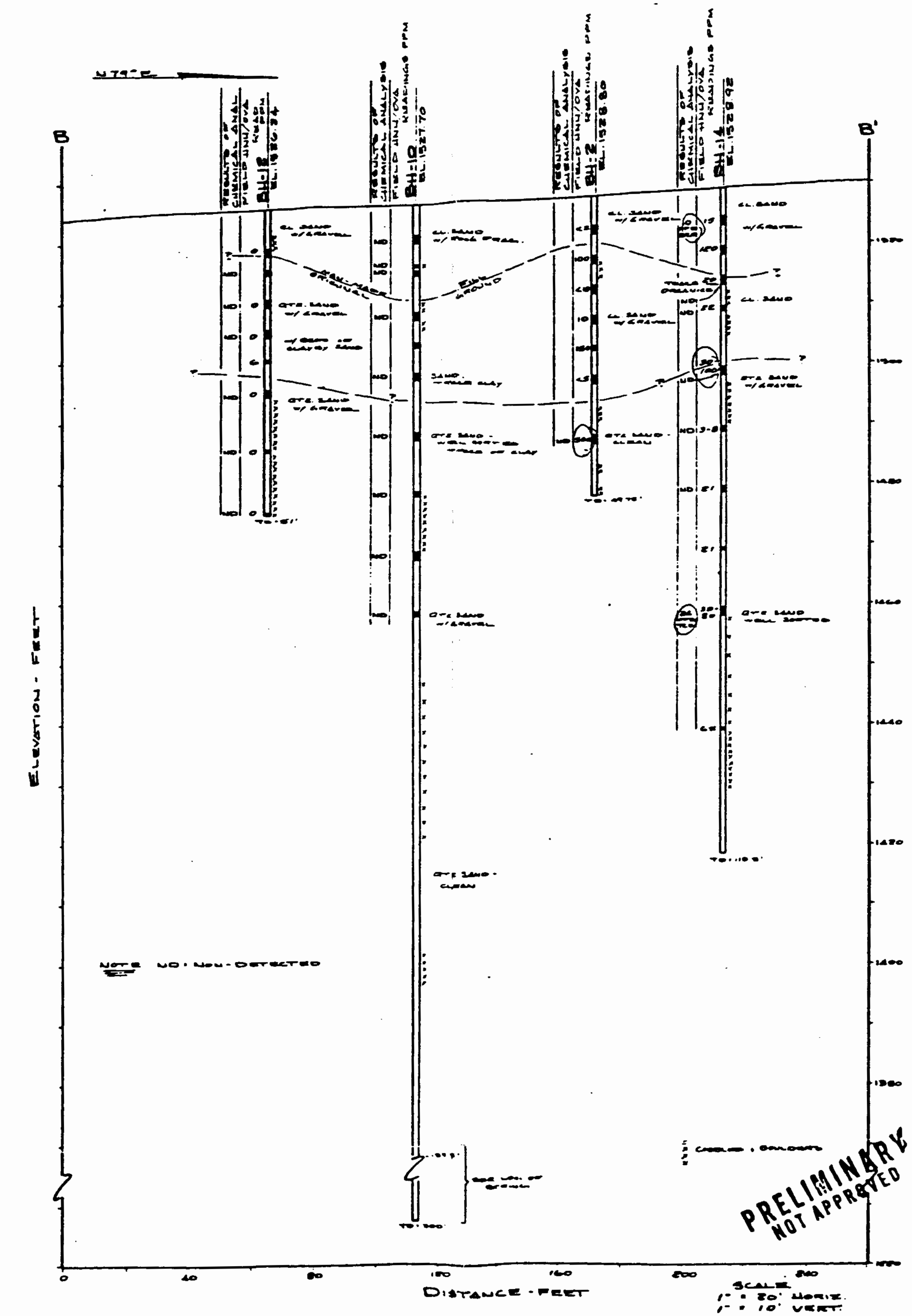
3. There is also no movement in a deep water body to the southwest or west, unless a future hole should encounter groundwater at an elevation above 1100 feet.

4. No perched groundwater other than a trace was found at either the 317 or 342 areas.

PRELIMINARY
NOT APPROVED

5. However, during wet weather, perched water has been noted discharging into the ravine to the south of the 317 area, and perched or surface water has contributed in the past to a pond 400 feet down-valley from the 342 area.



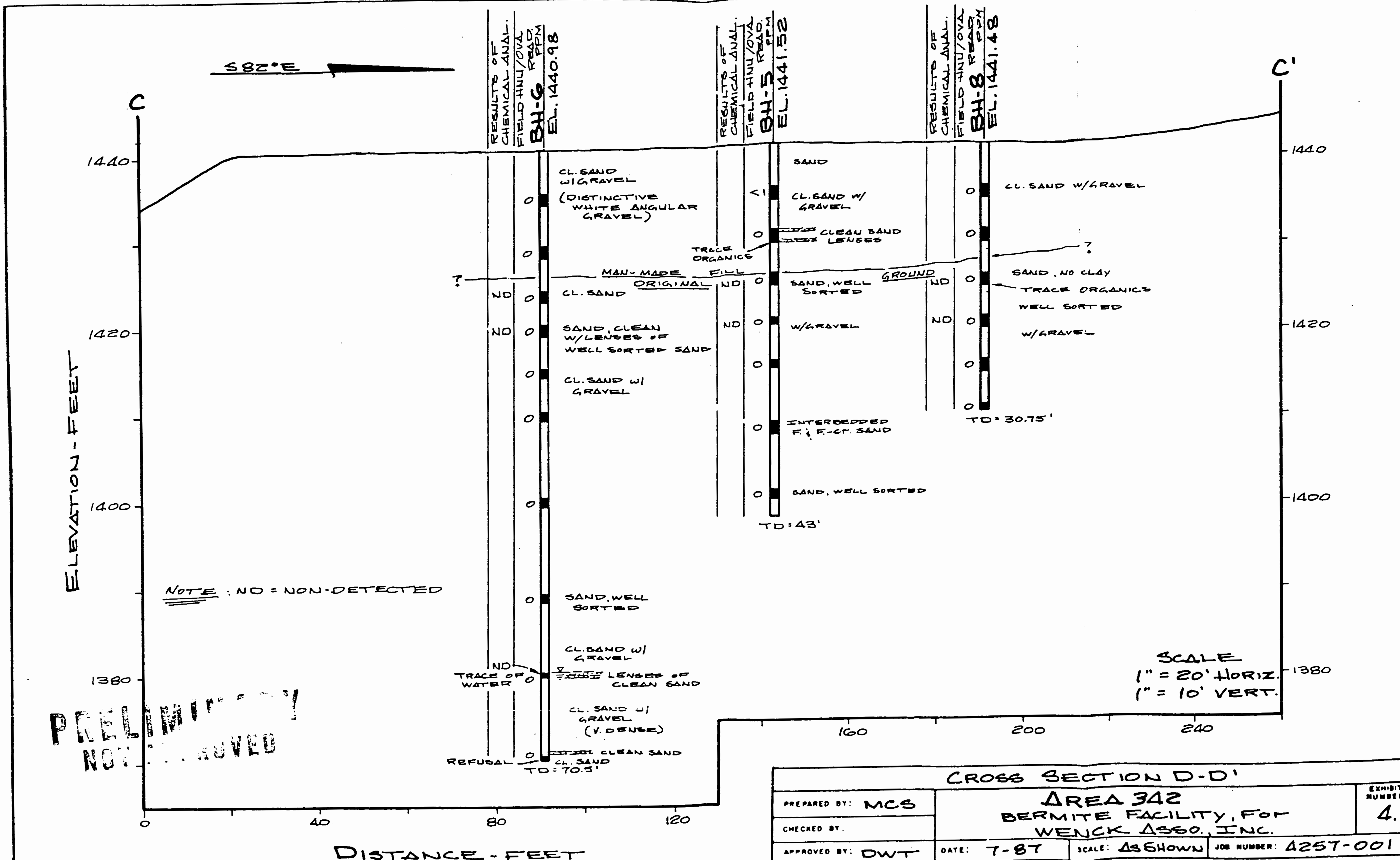


PRELIMINARY NOT APPROVED

pioneer consultants
GEOTECHNICAL ENGINEERS
Redlands, California

DATE JULY '87	SCALE AS SHOWN
JOB NO. 4257-001	EXHIBIT 3

AREA 31T - CROSS SECTIONS
BERMITE FACILITY
FOR
WELCK ASSO., INC.

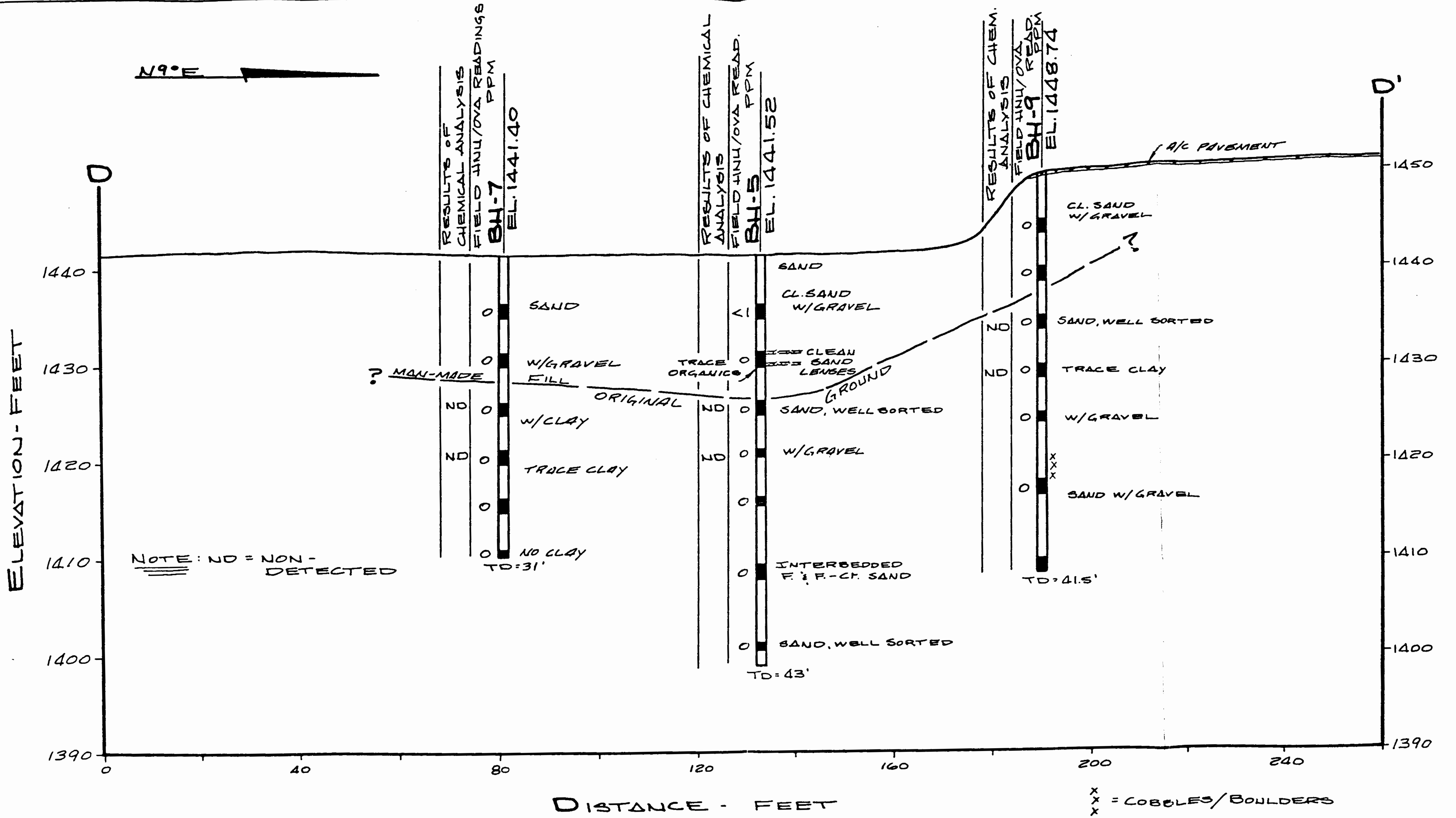


CROSS SECTION D-D'

PREPARED BY: MCS	AREA 342 BERMITE FACILITY, FOR WENCK ASSO., INC.	EXHIBIT NUMBER 4.
CHECKED BY:		
APPROVED BY: DWT	DATE: 7-87 / SCALE: AS SHOWN	JOB NUMBER: 4257-001

Pioneer Consultants

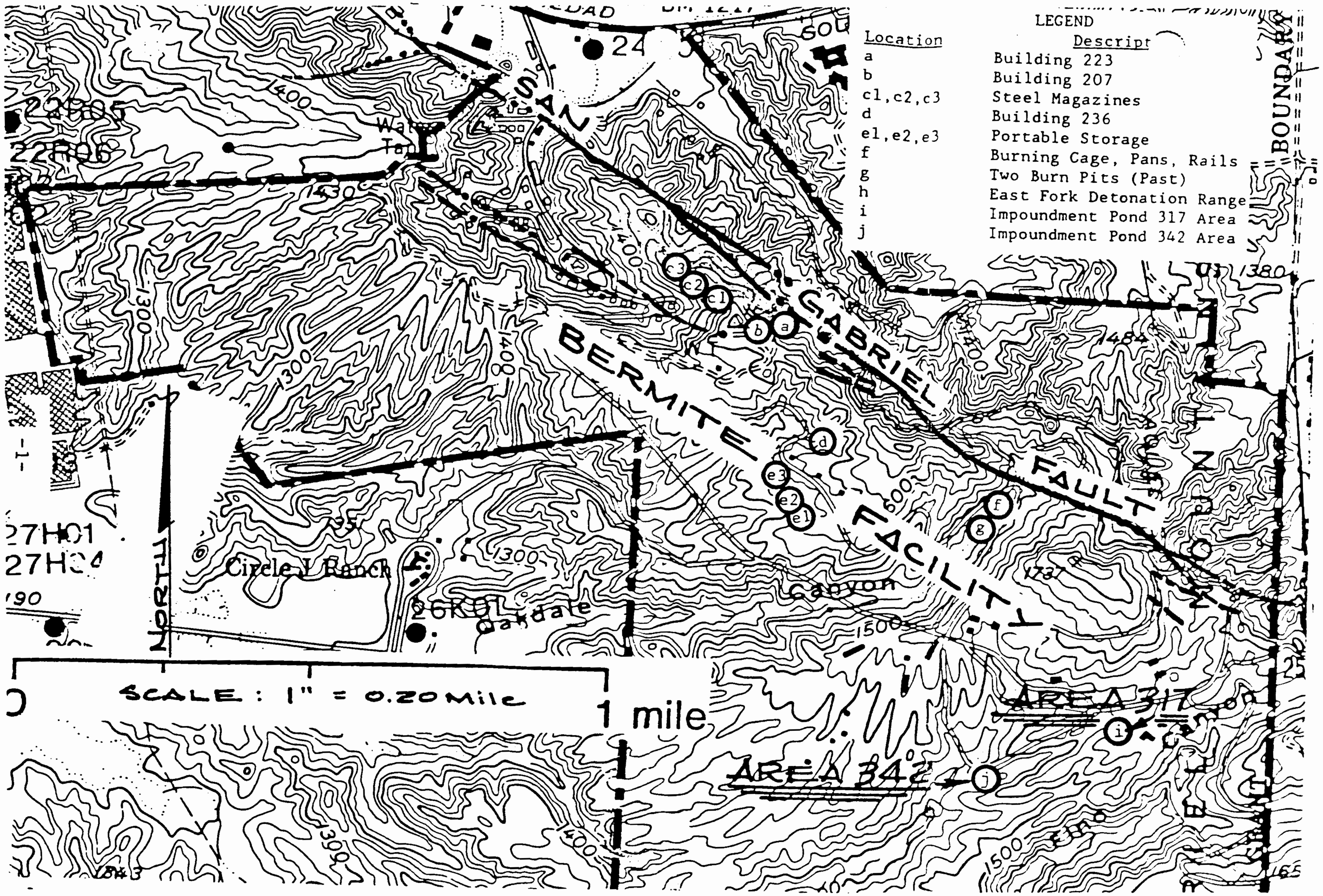
Consulting Engineers and Geologists



	CROSS SECTION C-C'		
PREPARED BY: MCS	AREA 342 BERMITE FACILITY, FOR WENCK ASSO., INC.		EXHIBIT NUMBER 5.
CHECKED BY:			
APPROVED BY: DWT	DATE: 7-87	SCALE: AS SHOWN	JOB NUMBER: 4257-001

Pioneer Consultants

Consulting Engineers and Geologists



EXPLANATION

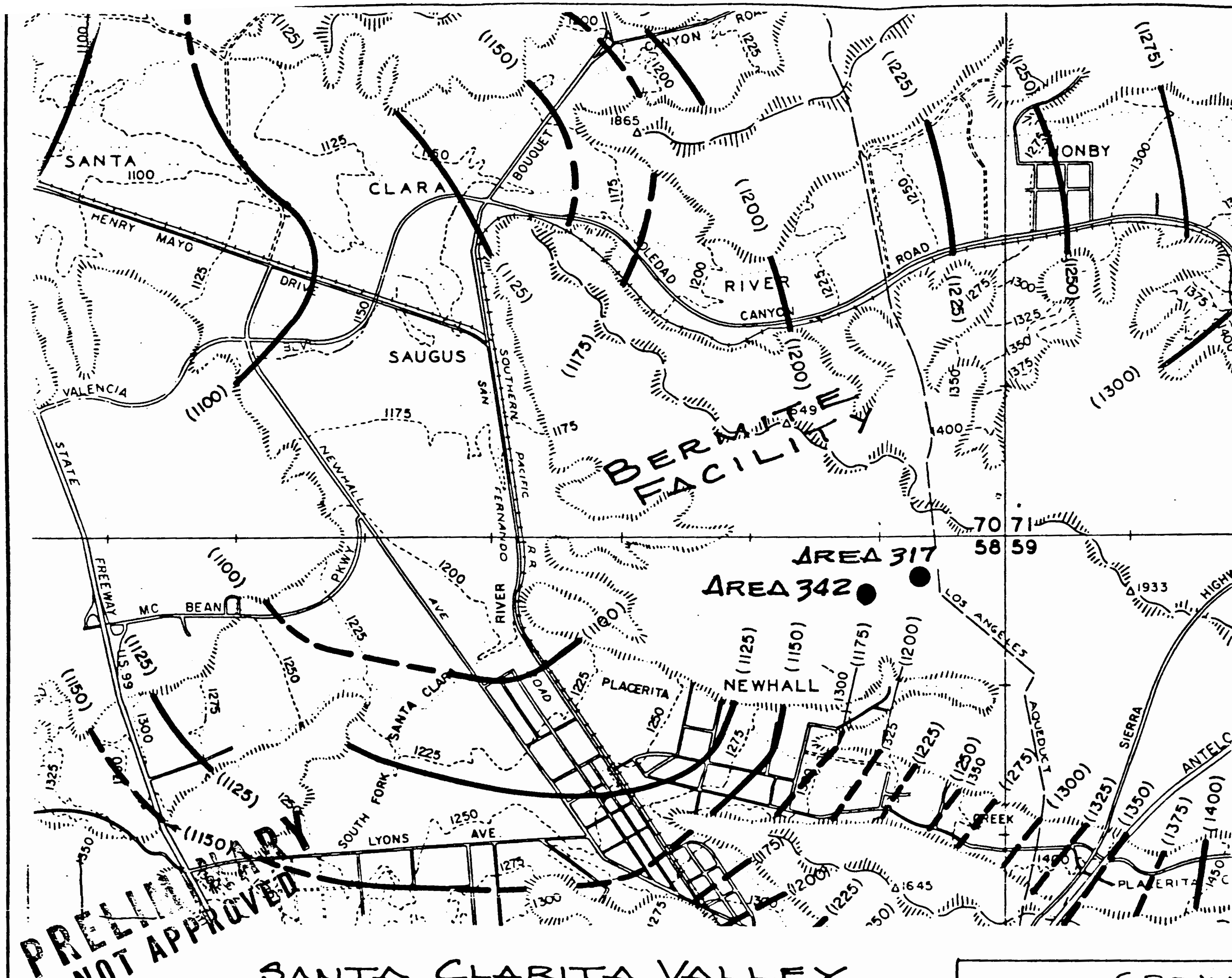
FAULT: DASHED WHERE APPROXIMATE; DOTTED WHERE BURIED.

(AFTER J.A. TREIMAN and F.H. WEBER)

NOT ... PROVED

FAULT MAP			
PREPARED BY: MCS	BERMITE FACILITY AREA for WENCK ASSO., INC.		EXHIBIT NUMBER A-1
CHECKED BY			
APPROVED BY: BB	DATE: 7-87	SCALE: AS SHOWN	JOB NUMBER: 4257-001

Pioneer Consultants — Consulting Engineers and Geologists



N

EXPLANATION

LINES OF EQUAL GROUNDWATER LEVEL

LINES OF EQUAL GROUNDWATER LEVEL; APPROX. LOCATION

900

GROUND SURFACE CONTOURS

SANTA CLARITA VALLEY GROUNDWATER CONTOURS for FALL - 1986

GROUNDWATER DATA

PREPARED BY: MCS	BERMITE FACILITY AREA for WENCK ASSO., INC.	EXHIBIT NUMBER A-2
CHECKED BY:		
APPROVED BY: BB	DATE: 7-87	SCALE: 1" = ½ Mile	JOB NUMBER: 4257-001

Pioneer Consultants — Consulting Engineers and Geologists

pioneer consultants
251 TENNESSEE STREET • REDLANDS, CALIFORNIA 92373
(714) 793-2691

TO: Wenck and Associates
832 Twelve Oaks Center
15500 Wayzata
Wayzata, Minnesota 55391

DATE: August 14, 1987

JOB NO. 4257-001

RE: Bermite Facility
Saugus, California

ATTENTION: Mr. Norman P. Wenck, P.E.
President

WE TRANSMIT TO YOU
[ ] SEPARATELY
[x] ENCLOSED

THE FOLLOWING: One copy of boring logs (BH-1 through H-15) drilled during June and July for the referenced project.

PURPOSE:
[x] FOR YOUR USE
[ ] FOR CHECKING
[ ] FOR APPROVAL
[x] AS REQUESTED
[ ] WORK ORDER
[ ] APPROVED
[ ] APPROVED AS NOTED
[ ] RETURNED FOR CORRECTION
[ ] FOR REVIEW AND COMMENT
[ ]

REMARKS

CC ______ [ ] W/ENC [ ] WO/ENC
______ [ ] W/ENC [ ] WO/ENC

pioneer consultants

BY Kyle D Emerson

Kyle D. Emerson, C.E.G. #1271
Project Geologist

BORING SUMMARY NO. BH-1

ELEVATION: N/I DATE DRILLED: June 22, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
							Asphalt concrete			
1							Clayey sand, medium to coarse, with 1 to 2-inch gravel (?fill) Reading: 0 ppm	dense	moist	reddish brown
6	G&B	29					Reading: 5 ppm			
10	G&B	50/5"					trace of cobbles gravels			
11										
12							TOTAL BORING DEPTH 11.0 FEET (REFUSAL; MOVED AHEAD 7.0 FEET) NO GROUNDWATER ENCOUNTERED			

G&B - Nominal 2-inch California modified
Reading taken with h.nu photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-1

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On

BORING SUMMARY NO. BH-2

ELEVATION: N/I DATE DRILLED: June 22, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
0–1							Debris (asphalt concrete paving)			gray
1–5							Clayey sand, medium to coarse, with 1-inch gravel and rock fragments	dense	moist	reddish brown
6	C&B	9					Reading: <2 ppm (no odor)			
7–8							Clayey sand to sandy clay			
9–14							Sand, fine to medium, with coarse sand (terrace deposit)			light brown
11	C&B	54					Gravels (1 inch) Reading: 100 ppm (original ground) less clay Sand, fine to very coarse, with 1 to 2-inch gravels			
15							(rock)		slightly moist	
16	C&B	80					Reading: <10 ppm			
20–21							Sand, medium to very coarse, and 1 to 2-inch gravel, trace of clay	very dense		
21–22	C&B	83/ 11"					Reading: 10 ppm			
25							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nu photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-2

Pioneer Consultants

JOB NUMBER: 4257-001

Approved for Report On ____________

BORING SUMMARY NO. BH-2

ELEVATION: N/I DATE DRILLED: June 22, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26	C&B	72/ 11"					Sand, medium to very coarse, with 1 to 2-inch gravel and trace of clay	very dense	slightly moist	light brown
27										
28										
29										
30										
31										
32	C&B	68					Reading: <5 ppm			
33										
34										
35							Gravels			
36										
37										
38										
39										
40										
41	C&B	50					Reading: 500 ppm (no odor) Fairly clean sand, fine to medium, with coarse sand, uniform			
42										
43										
44										
45							Gravels			
46										
47										
48							Gravels			
49										
50										

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

TOTAL BORING DEPTH 49.8 FEET (REFUSAL ON GRAVEL)
NO GROUNDWATER ENCOUNTERED

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-2

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-3

ELEVATION: N/I

DATE DRILLED: June 22, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
							Asphalt concrete			
1							Clayey sand, fine to medium, with 1-inch gravel, trace of cobbles	dense	slightly moist to moist	reddish brown
2										
3										
4										
5										
6	C&B	38					Reading: 3 ppm			
7										
8										
9										
10										
11										
12							TOTAL BORING DEPTH 9.5 FEET (REFUSAL) MOVED 4.0 FEET NO GROUNDWATER ENCOUNTERED			
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

C&B - Nominal 2-inch California modified
Reading taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-3

Pioneer Consultants

JOB NUMBER: 4257-001

Approved for Report On ______

BORING SUMMARY NO. BH-4

ELEVATION: N/I

DATE DRILLED: June 22, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
							2 inches asphalt concrete			
1–9							Clayey sand, fine to medium, with 1-inch gravel, trace of cobbles	dense	slightly moist to moist	reddish brown
10–25							TOTAL BORING DEPTH 9.5 FEET (REFUSAL) NO GROUNDWATER ENCOUNTERED			

C&B - Nominal 2-inch California modified
Reading taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-4

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ______

BORING SUMMARY NO. BH-5

ELEVATION: N/I DATE DRILLED: June 22, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
0–3							Sand, fine to medium	loose	slightly moist to dry	light brown
3–11							Sand, fine to medium, with coarse sand, clay, and pebbles, trace of gravel, trace of small cobbles	dense	slightly moist to moist	light reddish brown
6	C&B	12					Reading: <1 ppm			
10–11							Lenses of clean sand at 10 and 11 ft.			
11	C&B	46					Reading: 0 ppm trace of black organics			
11–15							Clean, rounded channel sand, medium to coarse, gravels Lenses of clean sand in fill	very dense	slightly moist	light brown
15–21							(Original Ground) Sand, medium to coarse, relatively uniform			light reddish brown
16	C&B	43					Reading: 0 ppm			
20	C&B	78/10"					Reading: 0 ppm			
21–23							Sand, medium to coarse, with small gravel			light brown
23–25							Sand, medium to coarse, fairly uniform (continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-5

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ________

BORING SUMMARY NO. BH-5

ELEVATION: N/I DATE DRILLED: June 22, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26	C&B	74					Sand, medium to coarse, fairly uniform Reading: 0 ppm	very dense	slightly moist	light brown
27										
28										
29										
30	C&B	50/4"					Reading: 0 ppm			
31										
32										
33	C&B	76					Sand, fine, interbedded with fine to coarse sand Reading: 0 ppm			
34										
35										
36										
37										
38										
39										
40	C&B	100					Sand, medium to coarse, uniform Reading: 0 ppm			
41										
42										
43										
44							TOTAL BORING DEPTH 43.0 FEET (REFUSAL ON ROCK) NO GROUNDWATER ENCOUNTERED			
45										
46										
47										
48										
49										
50										

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-5

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ______ By ______

BORING SUMMARY NO. BH-6

ELEVATION: N/I

DATE DRILLED: July 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
1–5							Clayey sand, fine to coarse, trace of 1 inch gravel (fill)	medium dense	moist	reddish brown
6	C&B	21					Reading: 0 ppm Clayey sand, fine to medium, with white angular gravel (1 to 2 inch size)			gray
12	C&B	22					Clayey sand, fine to coarse, with 1-inch gravel, trace of cobbles Reading: 0 ppm			
15							(Original Ground) Clayey sand, fine to coarse			reddish brown
17	C&B	24					Reading: 0 ppm			
21	C&B	76/ 11"					Channel sand, rounded, medium to coarse, with lenses of uniform sand, fine to medium, with 1 to 2-inch gravel, Reading: 0 ppm	very dense	slightly moist	light brown
25							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nµ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-6

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ______

BORING SUMMARY NO. BH-6

ELEVATION: N/I DATE DRILLED: July 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26	C&B	77					Sand, medium to coarse, rounded, channel, with lenses of uniform fine to medium sand, with 1 to 2-inch gravel	very dense	slightly moist	light brown
27							Reading: 0 ppm			
28							Sand, fine to coarse, with 1-inch gravel			
29										
30	C&B	94					Reading: 0 ppm			
31							(slightly dirty)			
32										
33										
34										
35										
36										
37										
38										
39										
40	C&B	84					Reading: 0 ppm			
41							Clayey sand, fine to medium, with 1-inch gravel and coarse sand		slightly moist to moist	light reddish brown
42										
43										
44										
45										
46										
47										
48										
49										
50										

(continued)

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-6

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-6

ELEVATION: N/I

DATE DRILLED: July 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
51							Uniform sand, fine to medium, with coarse sand and 1-inch gravel, with lenses of fine uniform sand	very dense	slightly moist	light brown
52	C&B	100+/ 8"								
53										
54										
55										
56										
57										
58										
59										
60							Clayey sand, fine to coarse, with ½ to 1-inch gravel		dry	reddish brown
61	C&B	90/ 9"					Reading: 0 ppm Uniform sand, medium, with ¼-inch pebbles	medium dense	very moist to wet	light brown
62										
63							Clayey sand with gravel	very dense		
64										
65										
66										
67										
68										
69							Reading: 0 ppm			
70	C&B	100/ 4½"					Lens of clean sand, fine to to coarse Gravels		dry	to reddish brown
71							TOTAL BORING DEPTH 70.5 FEET (REFUSAL IN VERY DENSE SAND) SEEPAGE ENCOUNTERED AT 60.5 FEET			
72										
73										
74										
75										

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-6

Pioneer Consultants

JOB NUMBER: 4257-001

Approved for Report on ____ by ____

BORING SUMMARY NO. BH-7

ELEVATION: N/I DATE DRILLED: June 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
1							Sand, fine to coarse, and pebbles (Fill)	loose	moist	reddish brown
2										
3										
4										
5							lenses of coarse, rounded sands		slightly moist	light brown
6	C&B	33					Reading: 0 ppm			
7										
8										
9										
10										
11	C&B	42					Reading: 0 ppm with ½ to 1-inch gravels			
12										
13							(Original Ground) with little clay			
14										
15										
16	C&B	64								
17										
18										
19										
20										
21	C&B	42					Reading: 0 ppm			
22										
23										
24										
25							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-7

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ______

BORING SUMMARY NO. BH-7

ELEVATION: N/I DATE DRILLED: June 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26	C&B	85/ 10"					Sand, fine to coarse, trace of clay (localized), with small gravels Reading: 0 ppm	very dense	slightly moist	light brown
27										
28										
29										
30							(no clay)			
31	C&B	90					Reading: 0 ppm			
32										
33							TOTAL BORING DEPTH 31.0 FEET NO GROUNDWATER ENCOUNTERED			
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-7

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-8

ELEVATION: N/I DATE DRILLED: June 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
1–5							Clayey sand, fine to medium, with coarse sand (Fill)	medium dense	moist	reddish brown
6	C&B	18					Reading: 0 ppm (no odor) Clayey sand, fine to coarse, with ½ to 1-inch gravel		moist to slightly moist	
11	C&B	34					Reading: 0 ppm (no odor) with 1-inch gravel and trace of cobbles	medium dense to dense		
15							(Original Ground?) Sand, fine to medium, with coarse sand, trace of organics	dense		light brown
16	C&B	43					Reading: 0 ppm)			
21	C&B	86/ 11"					Sand, uniform, fine to medium, with coarse sand Reading: 0 ppm (no odor)	very dense		
25							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nµ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-8

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ____

BORING SUMMARY NO. BH-8

ELEVATION: N/I

DATE DRILLED: June 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26	C&B	80					Sand, medium to very coarse, with 1 to 2-inch gravel Reading: 0 ppm (no odor)	very dense	slightly moist	light brown
27										
28										
29										
30							Reading: 0 ppm (no odor) Sand, fine to very coarse, with 1 to 2-inch gravel			
31	C&B	86/9"								
32										
33							TOTAL BORING DEPTH 30.8 FEET NO GROUNDWATER ENCOUNTERED			
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Approved For Repor. ... ___

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-8

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-9

ELEVATION: N/I

DATE DRILLED: June 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
0–8							Clayey sand, fine to medium, with coarse sand and 1 to 2-inch gravel (Fill)	medium dense	slightly moist to moist	reddish brown
6	C&B	20					Reading: 0 ppm (no odor)			
8–13							Sand, fine to medium, with ½ to 1-inch gravel and thin clayey lenses	dense to very dense	slightly moist	light brown
11	C&B	64					Reading: 0 ppm (no odor)			
13–16							(Original Ground) Uniform sand, fine, with silt, micaceous			reddish brown
16	C&B	60								
16–21							Sand, medium to coarse	very dense	dry to slightly moist	gray
21	C&B	56					Reading: 0 ppm (no odor)			
21–25							Sand, fine to medium, with coarse sand, trace of clay, with 1 to 2-inch gravel		moist	reddish brown
25							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nµ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-9

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ______

BORING SUMMARY NO. BH-9

ELEVATION: N/I   DATE DRILLED: June 23, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26	C&B	100/ 10"					Sand, medium to coarse, with 1 to 2-inch gravel Reading: 0 ppm	very dense	slightly moist	light brown
27										
28										
29										
30							Gravels			
31										
32							Sand, fine to coarse, with 1 to 2-inch gravel, trace of cobbles			
33	C&B	76					Reading: 0 ppm			
34										
35							TOTAL BORING DEPTH 33.5 FEET NO GROUNDWATER ENCOUNTERED			
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-9

Pioneer Consultants

JOB NUMBER: 4257-001

A... oved ... R... 1 0

BORING SUMMARY NO. BH-10

ELEVATION: N/I DATE DRILLED: June 24 and 25, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
							asphalt concrete			
1–5							Clayey sand, fine to medium, with rock fragments and 1-inch gravel, quartz and feldspar, well rounded with mica flanks and pebbles (Fill) (no odor)	medium dense to dense	dry to slightly moist	light brown to reddish brown w/rust streaks
6	C&B	31					(no odor)			
10							Sand becoming coarser Gravels	dense	slightly moist	reddish brown
12	C&B	80/ 11½"					Reading: 0 ppm (no odor) Clayey sand, fine to medium, with rock fragments and "gravel", with coarse sand and rounded pebbles (dirty)	very dense		light brown
17							Gravels and rock			
19	C&B	78					Sand, fine to medium, quartz subrounded, round pebbles, with coarse sand and 1-inch gravel and rock fragments (dirty) Reading: 4 ppm Gravels			
24	C&B	100/ 9"					Reading: 5 ppm Sand, medium to coarse (subangular, subrounded), with 1-inch gravels (rounded igneous, metamorphic)			

C&B - Nominal 2-inch California modified
Readings taken with h.nµ photoionization analyzer

(continued)

Approved For Report On ______

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I DATE DRILLED: June 24 and 25, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26–27							Sand, medium to coarse (subangular, subrounded) with 1-inch gravel (igneous and metamorphic, rounded)	very dense	slightly moist	light brown
27							(original ground)			
28							Fairly uniform quartz sands, fine to medium, with pebbles and 1-inch gravels, trace of clay with coarse sand			
29	C&B	88/ 10"					Reading: 10 to 15 ppm			
39	C&B	71					Reading: <1 ppm Uniform sand, fine, with a little clay interbedded with medium to coarse sand and 1-inch gravel			
48	C&B	100/ 7"					Sand, fine to coarse (quartz, pebbly), with 1-inch gravel (subangular to subrounded, quartz and feldspar) Reading: <1 ppm			
50							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On

BORING SUMMARY NO. BH-10

ELEVATION: N/I DATE DRILLED: June 24 and 25, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
51	G&B	50/ 6"					Sand, fine to coarse (pebbly quartz) with 1-inch gravel (subangular to subrounded, quartz and feldspar) Reading: 5 ppm)	very dense	slightly moist	light brown
52										
53										
54										
55							rock (boulders?)			
56										
57										
58										
59	G&B	100+					Reading: <1 ppm (no odor)			
60										
61										
62										
63										
64										
65										
66										
67										
68							Sand, fine to medium, with ½ to 1-inch gravel, coarse sand and rounded pebbles (subrounded quartz and feldspar to well rounded), trace of mica (Saugus?) Reading: 0 ppm (no odor)			
69	G&B	100+/ 10"								
70										
71										
72										
73										
74										
75							(continued)			

G&B - Nominal 2-inch California modified
Readings taken with h.nu photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I

DATE DRILLED: June 24 and 25, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
76							Sand, fine to medium, with ½ to 1-inch gravel, coarse sand and rounded pebbles, (subrounded quartz and feldspar to well rounded), trace of mica	very dense	slightly moist	light brown
77										
78										
79										
80							intermittent gravel beds (Saugus formation)			
81										
82										
83										
84										
85										
86										
87										
88										
89	C&B	43					(lost sample)			
90										
91										
92										
93										
94										
95										
96										
97										
98	C&B	68					Reading: 0 ppm probably debris, 1 to 2-inch gravel with medium to coarse sand			
99										
100							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

FORM [illegible]

Approved for Report on ——— By

BORING SUMMARY NO. BH-10

ELEVATION: N/I

DATE DRILLED: June 24 and 25, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
101–110							Sand, fine to medium, with coarse sand and intermittent gravel/cobble beds, with rounded pebbles and 1-inch gravels	very dense	slightly moist	light brown
110–120							Clean quartz sand, medium to very coarse, subangular to subrounded, few pebbles	medium dense		
120–125							Quartz sand, medium to coarse, with pebbles of metamorphics & volcanics	very dense		

Depth scale: 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125

(continued)

Approved For Report On

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I

DATE DRILLED: June 24 and 25, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
126							Quartz sand, medium to coarse, with pebbles of metamorphics and volcanics Cobbles/boulders	very dense	slightly moist	light brown
127										
128										
129							Quartz sand, fine to coarse, with pebbles of volcanic & metamorphic rocks			light brown/ gray
130							Quartz and feldspar (sub-angular, subrounded)			
131										
132										
133										
134										
135							Quartz sand, medium to very coarse			gray
136										
137										
138										
139										
140							Quartz sand, fine to very coarse, with feldspar (sub-angular to subrounded), trace of mica with round pebbles of metamorphic & volcanic rock			light brown
141										
142										
143										
144										
145										
146										
147										
148										
149										
150							(continued)			

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I DATE DRILLED: June 26, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
151							Quartz/feldspar sand, fine to very coarse, subangular, subrounded, well-rounded pebbles, trace of dark minerals	very dense	slightly moist	light brown
152										
153										
154										
155										
156										
157										
158										
159										
160							trace of mica			
161										
162										
163										
164										
165										
166										
167										
168										
169										
170							Quartz sand and feldspar, fine to very coarse, subangular, subrounded, trace of dark minerals, with round pebbles			
171										
172										
173										
174										
175							(continued)			

Approved For Report On ________

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHI[BIT] NUMB[ER] B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I DATE DRILLED: June 26, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
176							Quartz sand and feldspar, fine to very coarse, sub-angular, subrounded, trace of dark minerals, with round pebbles	very dense	slightly moist	light brown
177										
178										
179										
180										
181										
182										
183										
184										
185										
186										
187							(clay zone)			
188										
189										
190										
191							rock, trace of rock fragment			
192										
193										
194										
195										
196										
197										
198							rock			
199										
200							(continued)			

Approved For Report On: ______

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I DATE DRILLED: June 26, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
201							Quartz & feldspar sand (dirty), fine to very coarse subangular, subrounded (rock)	very dense	slightly moist	light brown
202										
203										
204										
205							rock			
206										
207										
208										
209										
210							granitic pebbles (subangular & subrounded)			
211										
212										
213										
214							clay bed			
215										
216										
217										
218										
219										
220										
221										
222										
223										
224										
225							(continued)			

Approved For Report On

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I DATE DRILLED: June 26, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
226							Quartz & feldspar sands (dirty), subangular, subrounded, fine to very coarse, round pebbles	very dense	slightly moist	light brown
227										
228										
229										
230										
231										
232										
233										
234										
235										
236										
237							rock/cobbles			
238										
239										
240										
241							trace of black sand, rock fragments			
242										
243										
244										
245										
246										
247										
248										
249										
250							(continued)			

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I

DATE DRILLED: June 26, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
251							Quartz & feldspar sands (dirty), subangular, sub-rounded, fine to very coarse, rounded pebbles	very dense	slightly moist	light brown
252										
253										
254										
255										
256										
257										
258										
259										
260										
261										
262							intermittent boulders			
263										
264										
265										
266										
267										
268										
269										
270										
271										
272										
273										
274										
275							(continued)			

Approved for Report on ———— B)

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-10

ELEVATION: N/I

DATE DRILLED: June 26, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
276 – 297							Quartz & feldspar sands (dirty), subangular, subrounded, fine to very coarse, with rounded pebbles and small percent of black sand	very dense	slightly moist	light brown
297 – 300							TOTAL BORING DEPTH 297.0 FEET NO GROUNDWATER ENCOUNTERED			

Depth scale: 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ______

BORING SUMMARY NO. BH-11

ELEVATION: N/I DATE DRILLED: July 29, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
1							Sand, medium to coarse, trace of clay with ½ to 1-inch gravel	medium dense to dense	slightly moist	light brown
6	C&B	47					Sample not retained			
8	C&B	30					Reading: 20 ppm			
11	C&B	62/ 10"					Clayey sand, fine to coarse, with 1 to 2-inch gravel Reading: <1 ppm		slightly moist to moist	reddish brown
16	C&B	100+					Decomposed granitic cobble/ boulder, coarse grained Reading: 0 ppm (slight odor)	very dense	slightly moist	gray
21	C&B	100+					Reading: 0 ppm (slight odor) Sand, medium to coarse, with clay and 1 to 2-inch gravel			light reddish brown
25							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-11

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ________ F ________

BORING SUMMARY NO. BH-11

ELEVATION: N/I

DATE DRILLED: June 29, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26–27	C&B	100/ 9"					Clayey sand, medium to coarse (quartz/feldspar), with 1 to 2-inch gravel subangular to subrounded), trace of magnetite(?) and micas Reading: 3 ppm (no odor)	very dense	slightly moist	light reddish brown
29–30	C&B	100+/ 10"					Reading: 0 ppm			
40–41	C&B	100+/ 10"					Reading: 0 ppm (no odor)			
50							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-11

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-11

ELEVATION: N/I DATE DRILLED: June 29, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
51	C&B	100+/ 11½"					Clayey sand, medium to coarse, subangular to subrounded, quartz/feldspar, trace of magnetite(?), mica with 1 to 2-inch gravel	very dense	slightly moist	light reddish brown
52										
53										
54							TOTAL BORING DEPTH 51.0 FEET NO GROUNDWATER ENCOUNTERED			
55										
56										
57										
58										
59										
60										
61										
62										
63										
64										
65										
66										
67										
68										
69										
70										
71										
72										
73										
74										
75										

C&B - Nominal 2-inch California modified

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-11

Pioneer Consultants

JOB NUMBER: 4257-001

FORM

BORING SUMMARY NO. BH-12

ELEVATION: N/I

DATE DRILLED: June 29, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
4							cobbles and boulders			
7	C&B	100 / 9"					Clayey sand, fine to coarse, with 1-inch gravel Reading: 0 ppm (no odor)	very dense	slightly moist	light brown
11	C&B	98/ 9"					Decomposed cobble/boulder Reading: 0 ppm			reddish brown
14										
15							Quartz sand, fine to coarse, with clayey sand and 1 to 2-inch gravel		dry to slightly moist	light brown
16	C&B	88					Reading: 0 ppm			
21	C&B	87/ 10"					interbedded fine to medium clayey sand and medium to coarse clean sand Reading: 0 ppm			
25							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Approved For Report On ______

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-12

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-12

ELEVATION: N/I   DATE DRILLED: June 29, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
	C&B	67/3"					Reading: 0 ppm			
26							Quartz sand, fine to coarse, with clayey sand and 1 to 2 inch gravel	very dense	dry to slightly moist	light brown
27										
28										
29										
30										
31	C&B	80/9" 9"					Quartz sand, medium to coarse, trace of clay and 1 to 2-inch gravel Reading: 0 ppm Gravels/cobbles (subangular to subrounded quartz and feldspar)		slightly moist	
32										
33										
34										
35										
36										
37							Boulders			
38										
39										
40	C&B	100+/ 6"					Reading: 0 ppm			
41										
42										
43										
44										
45										
46										
47										
48										
49										
50							(continued)			

C&B - Nominal 2-inch California modified
Reading taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-12

Pioneer Consultants   JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-12

ELEVATION: N/I | DATE DRILLED: July 29, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
51	G&B	100+/ 9"					Quartz sand, medium to coarse, trace of clay and 1 to 2-inch gravel Reading: 0 ppm Gravels/cobbles (subangular to subrounded quartz and feldspar)	very dense	slightly moist	light brown
52										
53										
54							TOTAL BORING DEPTH 51.0 FEET NO GROUNDWATER ENCOUNTERED			
55										
56										
57										
58										
59										
60										
61										
62										
63										
64										
65										
66										
67										
68										
69										
70										
71										
72										
73										
74										
75										

G&B - Nominal 2-inch California modified
Reading taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-10

Pioneer Consultants

JOB NUMBER: 4257-001

Approved for Report on ______

BORING SUMMARY NO. BH-13

ELEVATION: N/I DATE DRILLED: June 30, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
1										
2										
3										
4										
5										
6	C&B	100					Reading: 0 ppm (no odor) Clayey sand, fine to coarse, quartz and feldspar with 1 to 2-inch gravel	very dense	slightly moist	light reddish
7										
8										
9										
10										
11	C&B	100					Decomposed rock fragments Reading: 0 ppm			
12										
13										
14										
15										
16	C&B	100+/ 11"					Reading: 1 ppm			
17										
18										
19										
20										
21	C&B	100+/ 10"					Reading: 0 ppm Clayey quartz sand, fine to coarse, with 1 to 2-inch gravel		dry to slightly moist	light brown to light reddish brown
22										
23										
24							rocks			
25							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with organic vapor analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-13

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On ______

BORING SUMMARY NO. BH-13

ELEVATION: N/I

DATE DRILLED: June 30, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26							Clayey quartz sand, fine to coarse, with 1 to 2-inch gravel and rocks	very dense	dry to slightly moist	light brown to light reddish brown
28	C&B	86/ 11"					Reading: 8 ppm Quartz sand, fine to coarse, angular to subrounded, trace of clay Rocks and boulders			light brown
35	C&B	80/6"								
40	C&B	80/3"					No sample retained			
45	C&B	100/4"					Reading: 10 to 26 ppm (no odor)			
50							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with organic vapor analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-13

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-13

ELEVATION: N/I

DATE DRILLED: June 30, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
51							Quartz sand, fine to coarse, angular to subrounded, trace of clay Rocks and boulders	very dense	dry to slightly moist	light brown
52										
53										
54										
55										
56	C&B	100+/ 3"					with seams of red clay Reading: 10 ppm			
57										
58										
59										
60										
61										
62							intermittent rocks and boulders			
63										
64										
65										
66	C&B	100+/ 8"					Reading: 100 ppm Sand, fine to coarse (quartz and feldspar), with 1 to 2-inch gravel			
67										
68										
69										
70										
71										
72										
73										
74										
75							(continued)			

C&B - Nominal 2 inch California modified
Readings taken with organic vapor analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-13

Pioneer Consultants

JOB NUMBER: 4257-001

Approved for Record By: [illegible]

BORING SUMMARY NO. BH-13

ELEVATION: N/I | DATE DRILLED: June 30, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
76	C&B	100+/ 9½"					Sand, fine to coarse, with little clay and 1 to 2-inch gravel	very dense	moist to wet	brown
77							Reading: 10 to 40 ppm			
78										
79										
80										
81										
82										
83										
84										
85										
86							rock and boulders			
87										
88										
89							Reading: 36 ppm (no odor)			
90	C&B	100+/ 10"					Sand, fairly clean, medium to coarse (quartz with feld-spar), trace of mica and magnetite (subangular to subrounded) with 1 to 2-inch gravel, volcanic rock fragments		dry	light brown
91										
92										
93										
94							intermittent rock/boulders			
95										
96										
97										
98										
99										
100							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with organic vapor analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates, Inc.

EXHIBIT NUMBER B-13

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-13

ELEVATION: N/I DATE DRILLED: July 1, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
101							Sand, fairly clean, medium to coarse (quartz with feldspar), trace of mica and magnetite (subangular to subrounded) with 1 to 2-inch gravel, volcanic rock fragments, with intermittent rock and boulders	very dense	dry	light brown
102										
103										
104										
105										
106										
107										
108										
109										
110	C&B	100+/ 2"					Reading: 11 ppm			
111										
112										
113										
114										
115										
116										
117										
118										
119										
120										
121										
122										
123										
124										
125							(continued)			

C&B - Nominal 2-inch California modified
Reading taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-13

Pioneer Consultants

JOB NUMBER: 4257-001

Approved for Report By

BORING SUMMARY NO. BH-13

ELEVATION: N/I DATE DRILLED: July 1, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
126							Sand, fairly clean, medium to coarse (quartz with fledspar), trace of mica and magnetite (subangular to subrounded) with 1 to 2-inch gravel, volcanic rock fragments, with intermittent rock and boulders	very dense	dry	light brown
127										
128										
129									slightly moist	
130	C&B	100/ 1½"					Reading: 30 ppm			
131										
132							TOTAL BORING DEPTH 130.0 FEET NO GROUNDWATER ENCOUNTERED			
133										
134										
135										
136										
137										
138										
139										
140										
141										
142										
143										
144										
145										
146										
147										
148										
149										
150										

C&B - Nominal 2-inch California modified
Readings taken with h.nµ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates, Inc.

EXHIBIT NUMBER B-13

Pioneer Consultants

JOB NUMBER: 4257-001

FORM 4260C

BORING SUMMARY NO. BH-14

ELEVATION: N/I

DATE DRILLED: July 1, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
							asphalt concrete			
1							Slightly clayey sand, fine to medium, with ½-inch gravel	medium dense	slightly moist	brown
2										
3										
4										
5										
6	C&B	36					Clayey sand, fine to coarse, with 1-inch gravel Reading: 15 ppm (no odor)		slightly moist to moist	reddish brown
7										
8										
9										
10										
11	C&B	15					Reading: 120 ppm			
12										
13										
14										
15							organics (Reading: 2 ppm)			dk. brown to black
16	C&B	38/ 10"					Clayey sand, fine to medium, with coarse sand and 1 to 2-inch gravel, intermittent rock (original ground) Reading: 20 ppm	dense		
17										
18										
19							rock and boulders			
20										
21	C&B	100/9"					Slightly clayey sand, fine to coarse (quartz with feld-spar), with ½ to 1-inch gravel Reading: 5 to 15 ppm		slightly moist	
22										
23										
24										
25							(continued)			

C&B Nominal 2-inch California modified
Readings taken with organic vapor analyzer, except at 21 ft. used h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-14

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-14

ELEVATION: N/I

DATE DRILLED: July 1, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26–28	C&B	50/1"					Sample not recovered Slightly clayey sand, fine to coarse (quartz with feld-spar), with ½ to 2-inch gravel	dense	slightly moist	reddish brown
28–31							Uniform quartz sand, fine to medium, with coarse sand and 1 to 2-inch gravel			light brown
31–33	C&B	92/11"					Reading: 30 ppm layer of clayey sand, fine coarse, with 1-inch gravel intermittent rock			
40–42	C&B	82					Reading: 3 to 8 ppm Quartz sand, fine to medium, trace of clay with ½-inch rock fragments and 1-inch gravel	very dense		

(continued)

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-14

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-14

ELEVATION: N/I

DATE DRILLED: July 1, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
51	C&B	100+					Quartz sand, medium to coarse (subangular to subrounded), with 1-inch gravel, little feldspar, and trace of mica Reading: 21 ppm	very dense	dry to slightly moist	light brown
52										
53										
54										
55										
56										
57										
58										
59										
60	C&B	100+/ 8"					Reading: 21 ppm			
61										
62										
63										
64										
65										
66										
67										
68										
69										
70							Quartz sand, uniform, fine		slightly moist	
71	C&B	83/9"					Quartz sand, fine to medium, with coarse sand and little feldspar, fairly uniform Reading: 35 to 80 ppm			
72										
73										
74										
75							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with h.nμ photoionization analyzer at 51.0 feet; the organic vapor analyzer was used at 60.0 and 7.5 feet.

Approved For Report On ______ By: ______

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-14

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-14

ELEVATION: N/I

DATE DRILLED: July 2, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
76							Quartz sand, fine to medium, with coarse sand and little feldspar, fairly uniform	very dense	slightly moist	light brown
77										
78										
79										
80										
81										
82										
83										
84										
85										
86										
87										
88										
89										
90	C&B	8/ 11"					Reading: 65 ppm with 1-inch angular rock fragments (?debris) continuous rock/boulders	loose		
91										
92										
93										
94										
95										
96										
97										
98										
99										
100							(continued)			

C&B - Nominal 2-inch California modified
Readings taken with organic vapor analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates, Inc.

EXHIBIT NUMBER B-14

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-14

ELEVATION: N/I   DATE DRILLED: July 2, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
101							Quartz sand, fine to medium, with coarse sand and little feldspar, fairly uniform, with 1 to 2-inch angular rock fragments, and intermittent rock/boulders	very dense	slightly moist	light brown
102										
103										
104										
105										
106										
107										
108										
109										
110	C&B	48								
111							TOTAL BORING DEPTH 110.0 FEET NO GROUNDWATER ENCOUNTERED			
112										
113										
114										
115										
116										
117										
118										
119										
120										
121										
122										
123										
124										
125										

C&B - Nominal 2-inch California modified

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-14

Pioneer Consultants

JOB NUMBER: 4257-001

BORING SUMMARY NO. BH-15

ELEVATION: N/I

DATE DRILLED: July 8, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
1							Quartz sands, fine to coarse, with ½ to 1-inch gravel	dense	dry to slightly moist	light brown
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13							rock			
14										
15										
16										
17										
18										
19										
20										
21	C&B	29					Reading: 1 ppm trace of mica		very slightly moist	
22										
23										
24										
25										

C&B - Nominal 2-inch California modified
Reading with organic vapor analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-15

Pioneer Consultants

JOB NUMBER: 4257-001

Approved For Report On

BORING SUMMARY NO. BH-15

ELEVATION: N/I DATE DRILLED: July 8, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	RELATIVE COMPACTION %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
26–27							Quartz sand, fine to medium, with coarse sand and ½ to 1-inch gravel (angular), trace of mica	dense	very slightly moist	light brown
28–40										
41	C&B	50					Quartz sand, fine to medium, with coarse sand and ½ to 1½-inch gravel, trace of clay, with pebbles Reading: 1 to 2 ppm	very dense	dry to very slightly moist	light brown to light reddish brown
46							rock			
50							(continued)			

C&B - Nominal 2-inch California modified
Reading taken with h.nμ photoionization analyzer

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-15

Pioneer Consultants JOB NUMBER: 4257-001

Approved ... Report O... J.V.

BORING SUMMARY NO. BH-15

ELEVATION: N/I

DATE DRILLED: July 8, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
51							Quartz sand, fine to medium, with coarse sand, ½ to 1½-inch gravel and pebbles, trace of clay	very dense	dry to very slightly moist	light brown to light reddish brown
52										
53										
54										
55										
56										
57										
58										
59										
60										
61	C&B	100+/ 11"					Quartz sand, fine to coarse, with 1 to 2-inch gravel and pebbles Reading: 3 ppm		dry to slightly moist	light brown
62										
63										
64										
65										
66										
67										
68										
69										
70										
71										
72										
73										
74										
75							(continued)			

C&B - Nominal 2-inch California modified
Reading taken with h.nµ photoionization analyzer

Approved For Report On

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-15

Pioneer Consultants

JOB NUMBER: 4257-001

FORM #2606

BORING SUMMARY NO. BH-15

ELEVATION: N/I   DATE DRILLED: July 9, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
76							Quartz sand, fine to coarse, with 1 to 2-inch gravel and pebbles	very dense	dry to slightly moist	light brown
77										
78										
79										
80							rock			
81										
82										
83	C&B	100+/ 11½"					Quartz sand, fine to medium, with coarse sand and ½ to 1-inch gravel, trace of clay Reading: 2 ppm			light brown to light reddish brown
84										
85										
86										
87										
88										
89										
90										
91										
92										
93										
94										
95										
96										
97										
98										
99										
100							(continued)			

C&B - Nominal 2-inch California modified
Reading taken with h.nμ photoionization analyzer

Approved For Report On

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-15

Pioneer Consultants

JOB NUMBER: 4257-001

FORM 4-5OC

BORING SUMMARY NO. BH-15

ELEVATION: N/I DATE DRILLED: July 9, 1987

DEPTH IN FEET	SAMPLES	BLOW COUNT PER FOOT	FIELD MOISTURE % DRY WEIGHT	DRY DENSITY LB./CU. FT.	Relative Compaction %	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION			
101–102	C&B	80/7"					Quartz sand, fine to medium, with coarse sand and ½ to 1-inch gravel, trace of clay Sample not retained.	very dense	dry to slightly moist	light brown to light reddish brown
103–125							TOTAL BORING DEPTH 101.5 FEET NO GROUNDWATER ENCOUNTERED			

C&B - Nominal 2-inch California modified

Whittaker Corp. Bermite Facility
Saugus, California
for Wenck Associates Inc.

EXHIBIT NUMBER B-15

Pioneer Consultants

JOB NUMBER: 4257-001

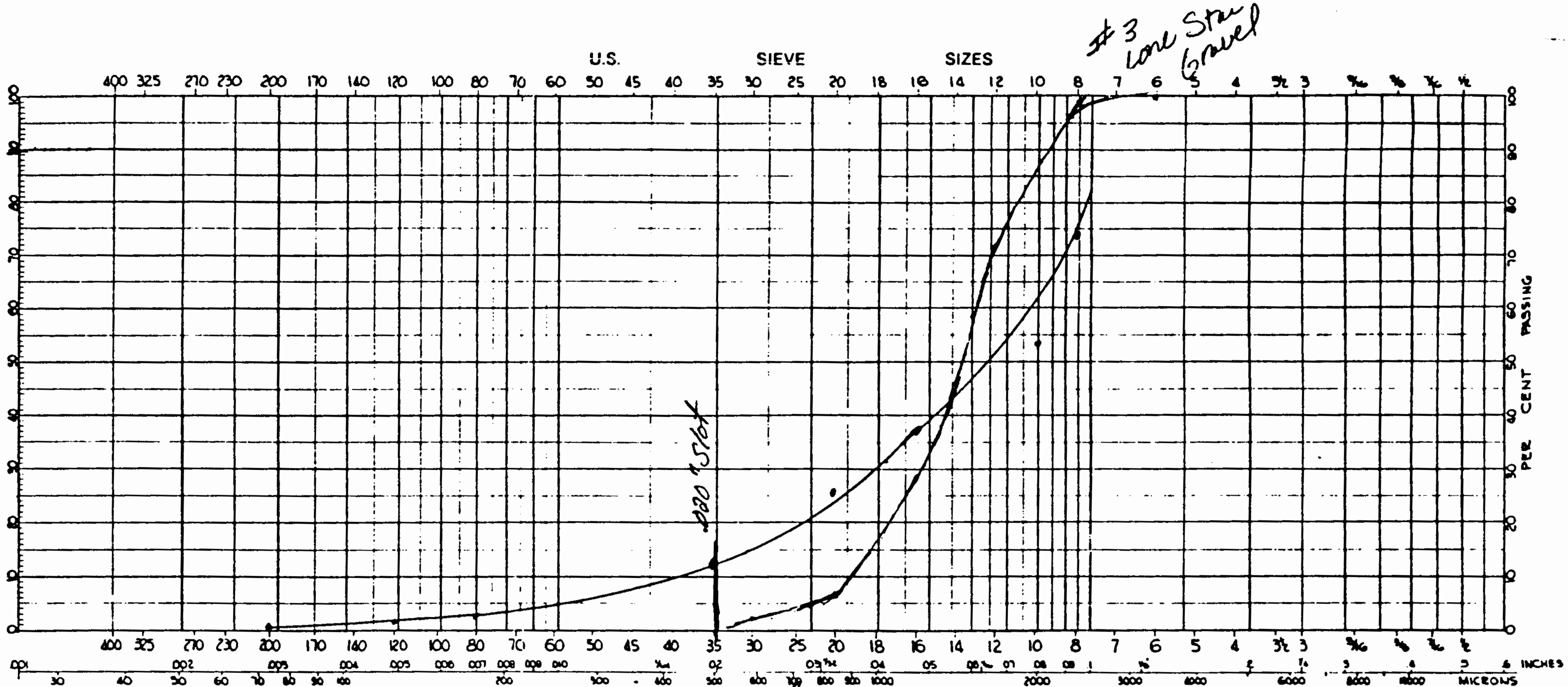
FORM

APPENDIX C

GRAIN SIZE ANALYSIS FROM BORING AND WELLS

AT THE BERMITE FACILITY

WATER WELL GRAVEL PACK AND FORMATION MECHANICAL GRADING ANALYSIS



Lone Star #3 Gravel

Formation Analysis Screen Size	Formation Analysis % Passing	Gravel Pack Analysis Screen Size	Gravel Pack Analysis % Passing
8	74.0	6	100
10	53.0	8	99
16	36.9	12	72
20	53.5	16	28
35	12.9	20	7
80	2.4	30	2.5
120	1.2		
200	0.5.		

Customer Bermite

Well Name & Number W-1

Well Location EAST OF 317

Gravel Name or Number LONE STAR #3

Vendor

Driller TRUDELL DRILLING CO.

Date DEC. 10, 1987

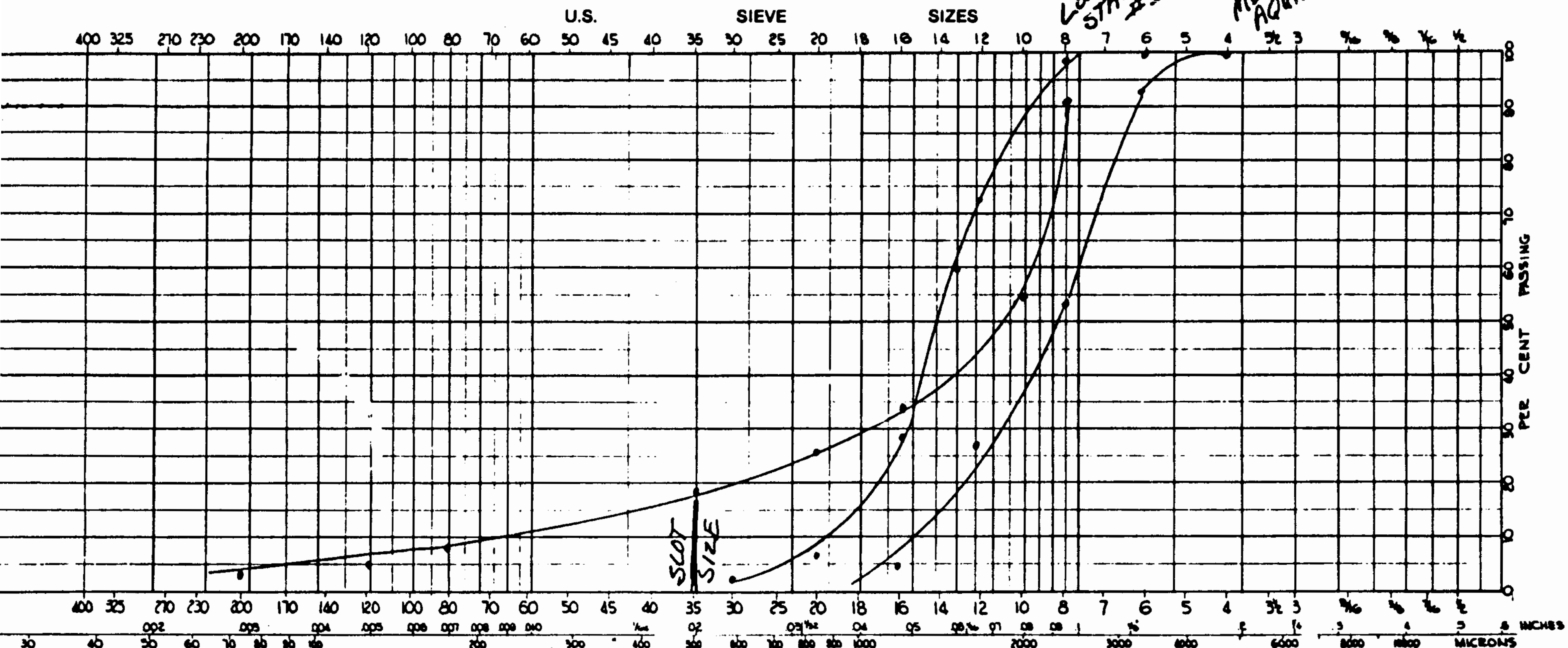
Roscoe Moss Company

4360 Worth Street
Los Angeles, California
90063

213-263-4111

P.O. Box 31064
Los Angeles, California
90031

WATER WELL GRAVEL PACK AND FORMATION MECHANICAL GRADING ANALYSIS



Lone Star #3

Formation Analysis		Gravel Pack Analysis	
Screen Size	% Passing	Screen Size	% Passing
8	90.5	6	100
10	54.7	8	99
16	34.0	12	72
20	26.5	16	28
35	18.4	20	7
80	7.9	30	2
120	5.3		
200	3.9		

Customer Bermite / Trudel

Well Name & Number W-2

Well Location SOUTH OF 342

Gravel Name or Number LONE STAR #3

Vendor

Driller TRUDELL DRILLING CO. / WAYNE PARNELL

Date

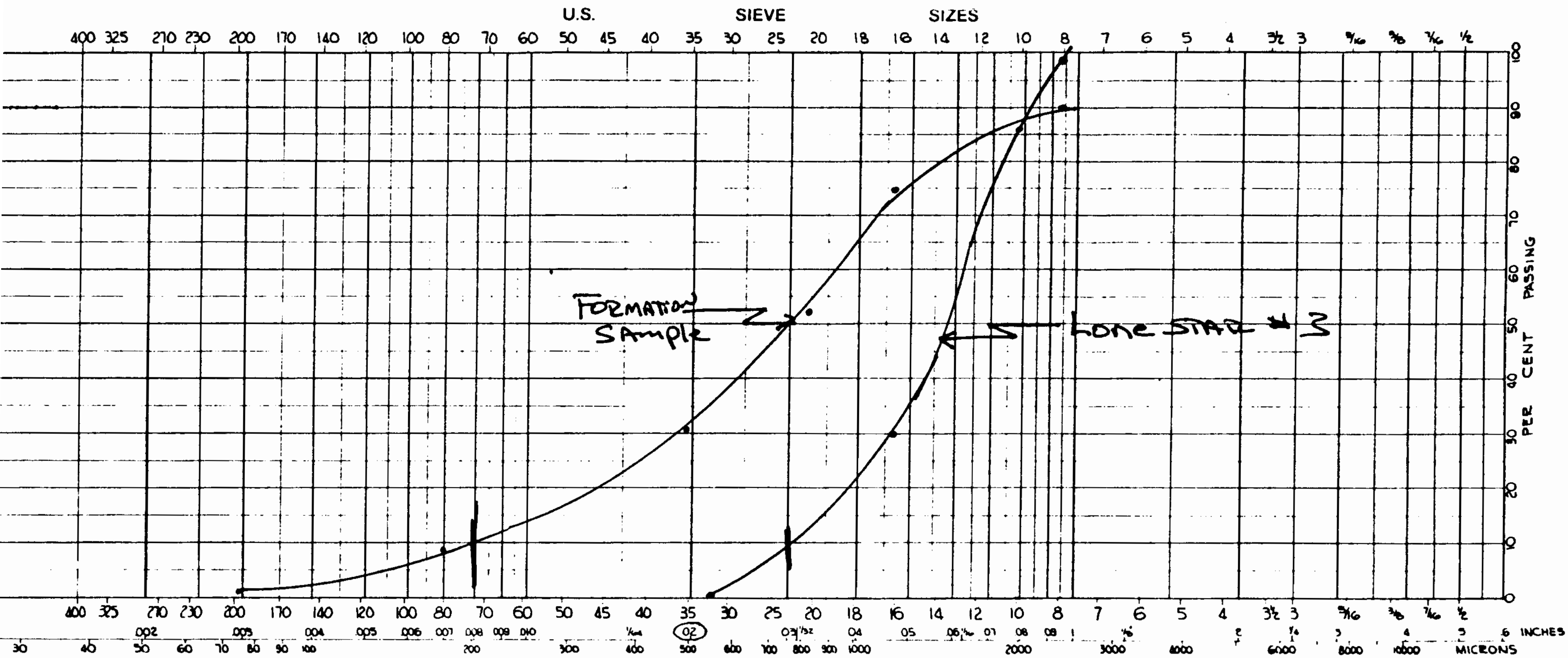
Roscoe Moss Company

4360 Worth Street
Los Angeles, California
90063

213-263-4111

P.O. Box 31064
Los Angeles, California
90031

WATER WELL GRAVEL PACK AND FORMATION MECHANICAL GRADING ANALYSIS



Formation Analysis		Gravel Pack Analysis	
Screen Size	% Passing	Screen Size	% Passing
8	90		
10	86		
16	75		
20	52		
35	31		
80	8		
120	4		
200	3		

Customer Bermite

Well Name & Number W-3

Well Location Southwest of 317

Gravel Name or Number Lone Star #3

Vendor

Driller Trudell Drilling Co.

Date 1/12/88

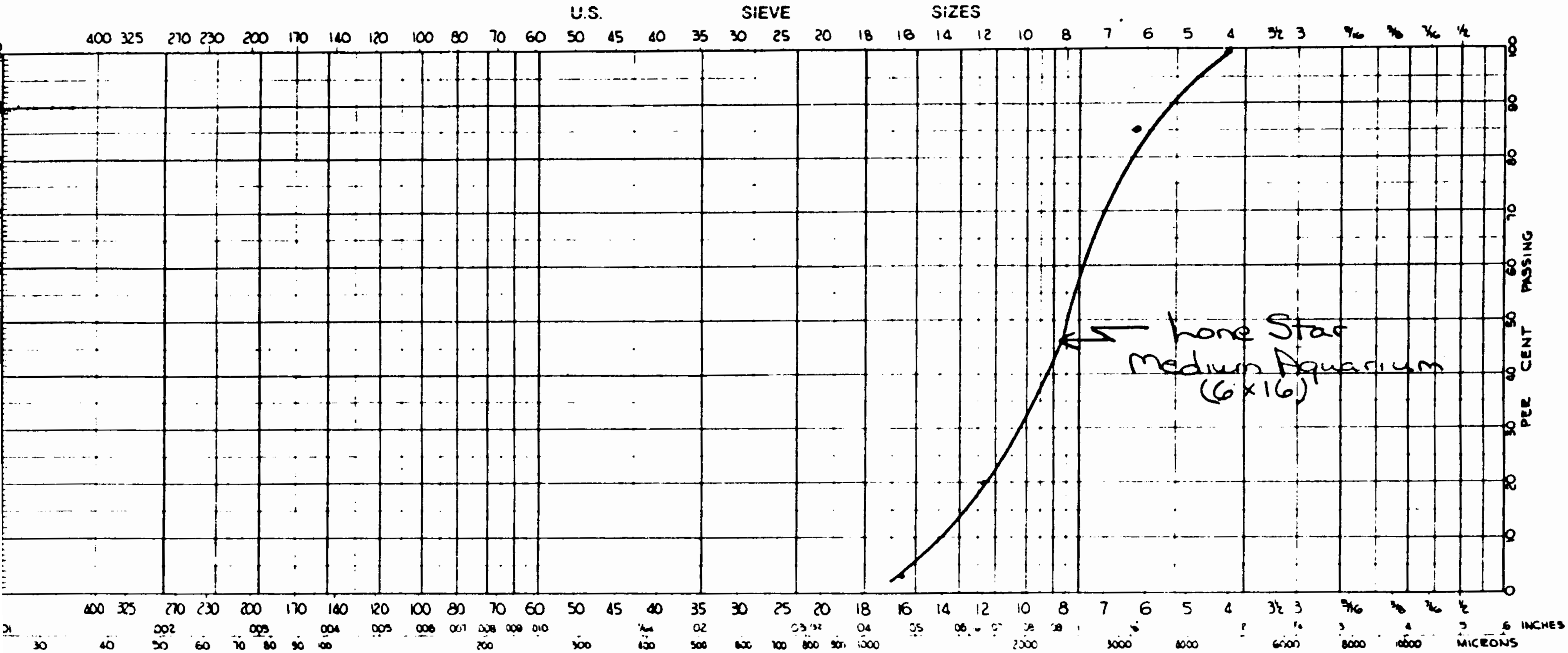
Roscoe Moss Company

4360 Worth Street
Los Angeles, California
90063

213-263-4111

P.O. Box 31064
Los Angeles, California
90031

WATER WELL GRAVEL PACK AND FORMATION MECHANICAL GRADING ANALYSIS



Formation Analysis Screen Size	% Passing	Gravel Pack Analysis Screen Size	% Passing
		4	100
		6	85
		8	46
		12	20
		16	3

Customer DOHS ?

Well Name & Number

Well Location

Gravel Name or Number

Vendor

Driller

Date 5/26/88

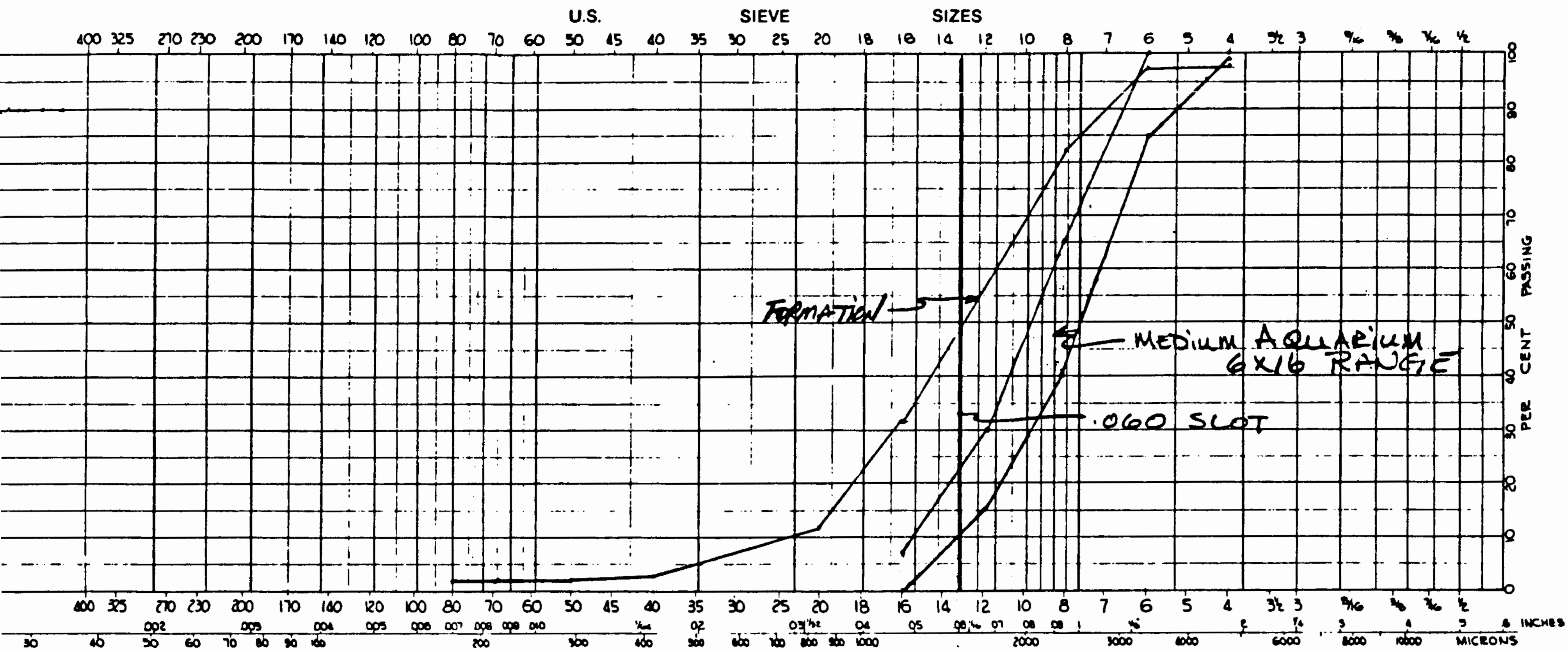
Roscoe Moss Company

4360 Worth Street
Los Angeles, California
90063

213-263-4111

P.O. Box 31064
Los Angeles, California
90031

...ATER WELL GRAVEL PACK AND FORMATION MECHANICAL GRADING ANALYSIS



Formation Analysis		Gravel Pack Analysis	
Screen Size	% Passing	Screen Size	% Passing
4	98.0	4	99-100
6	97.5	6	85-100
8	82.6	8	40-65
16	31.6	12	15-30
20	11.6	16	0-7
40	2.8		
50	1.9		
70	1.6		
80	1.4		

↓

Customer BERMITE

Well Name & Number

Well Location #5

Gravel Name or Number MEDIUM AQUARIUM (8X16)

Vendor

Driller BEYLIK

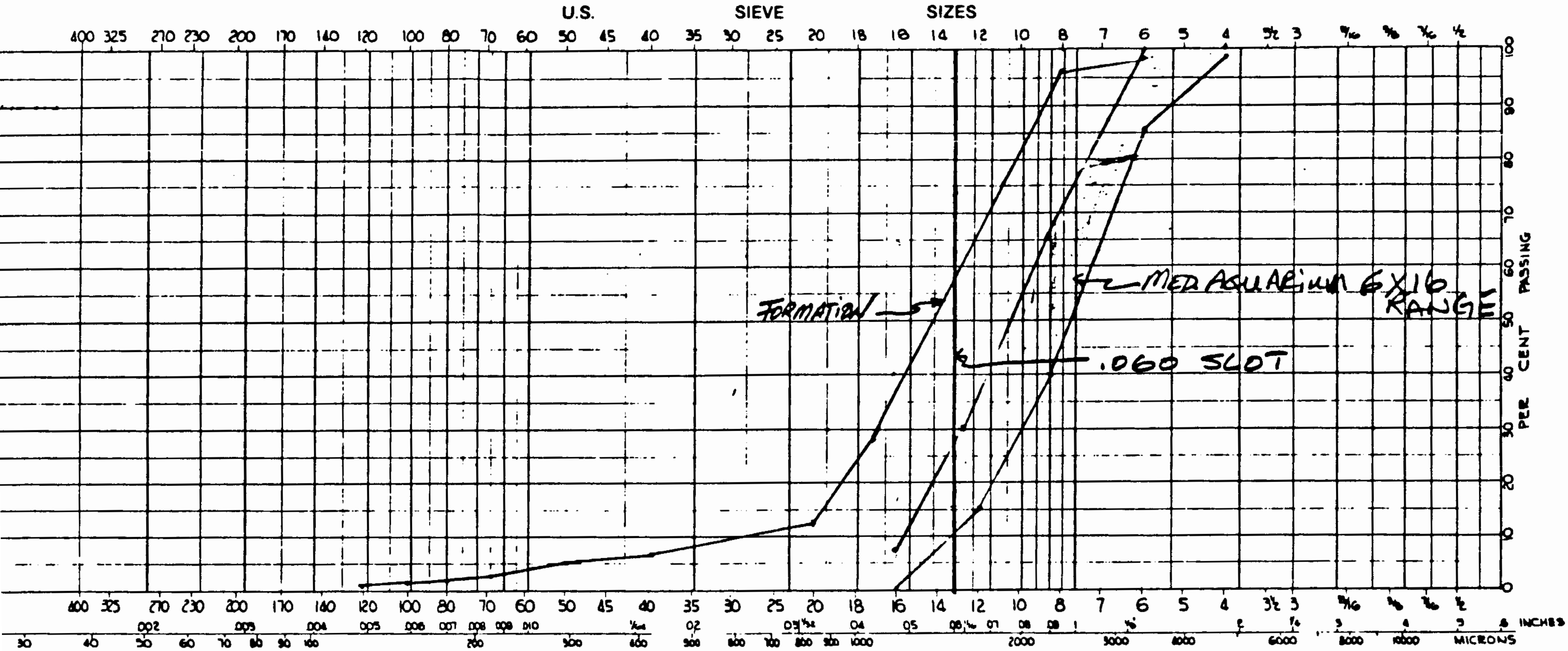
Date JULY 11, 1988

Roscoe Moss Company

4360 Worth Street
Los Angeles, California
90063

213-263-4111

P.O. Box 31064
Los Angeles, California
90031



Formation Analysis		Gravel Pack Analysis	
Screen Size	% Passing	Screen Size	% Passing
6	99	4	99-100
8	96	6	85-100
16	28	8	40-65
20	12	12	15-30
40	6	16	0-7
50	5		
70	3		
80 100	2 2		
120	1		

Customer BERMITE

Well Name & Number

Well Location #6

Gravel Name or Number

Vendor

Driller BEYLIK

Date

Roscoe Moss Company

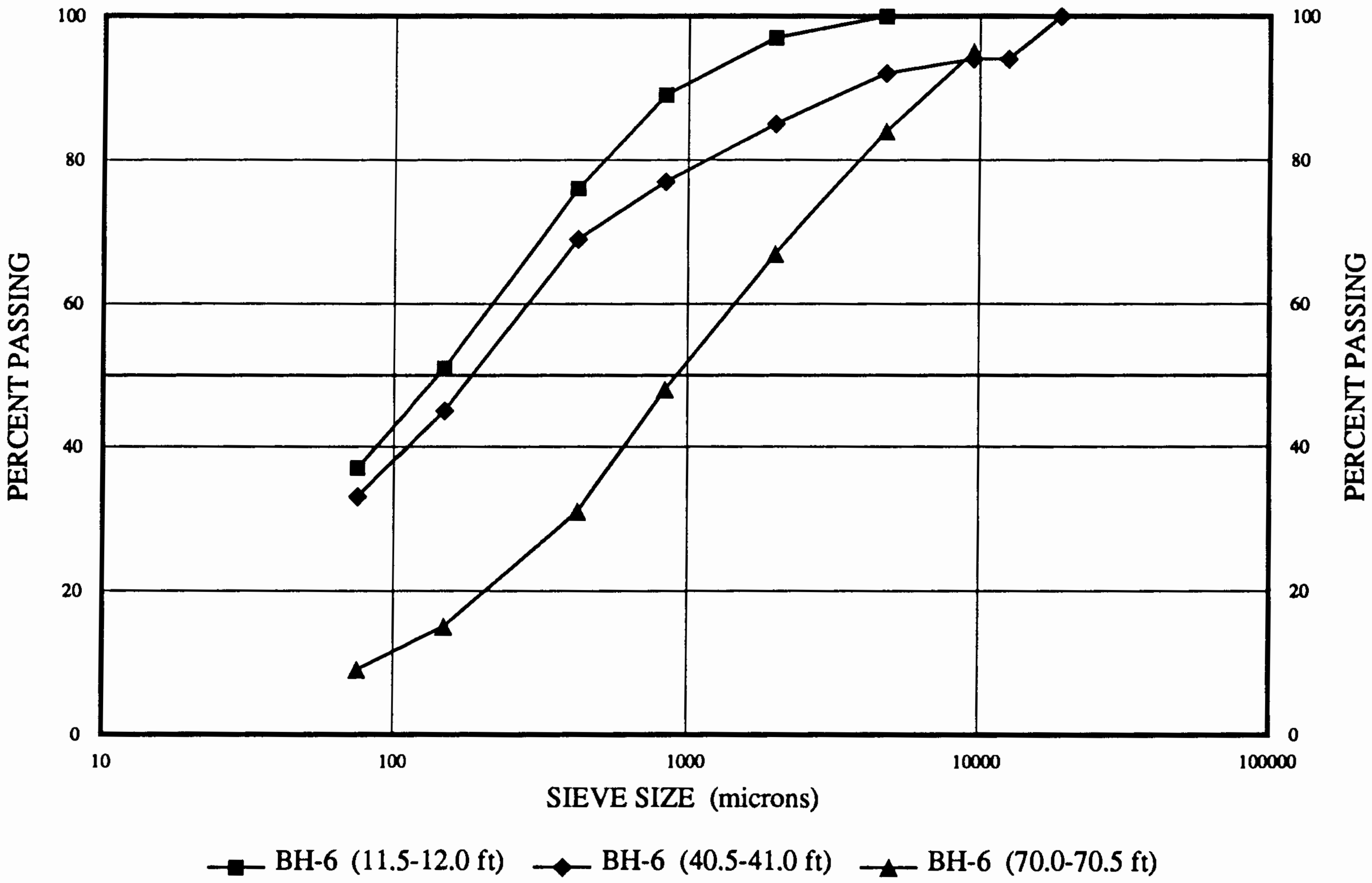
4360 Worth Street
Los Angeles, California
90063

213-263-4111

P.O. Box 31064
Los Angeles, California
90031

GRAIN SIZE ANALYSIS

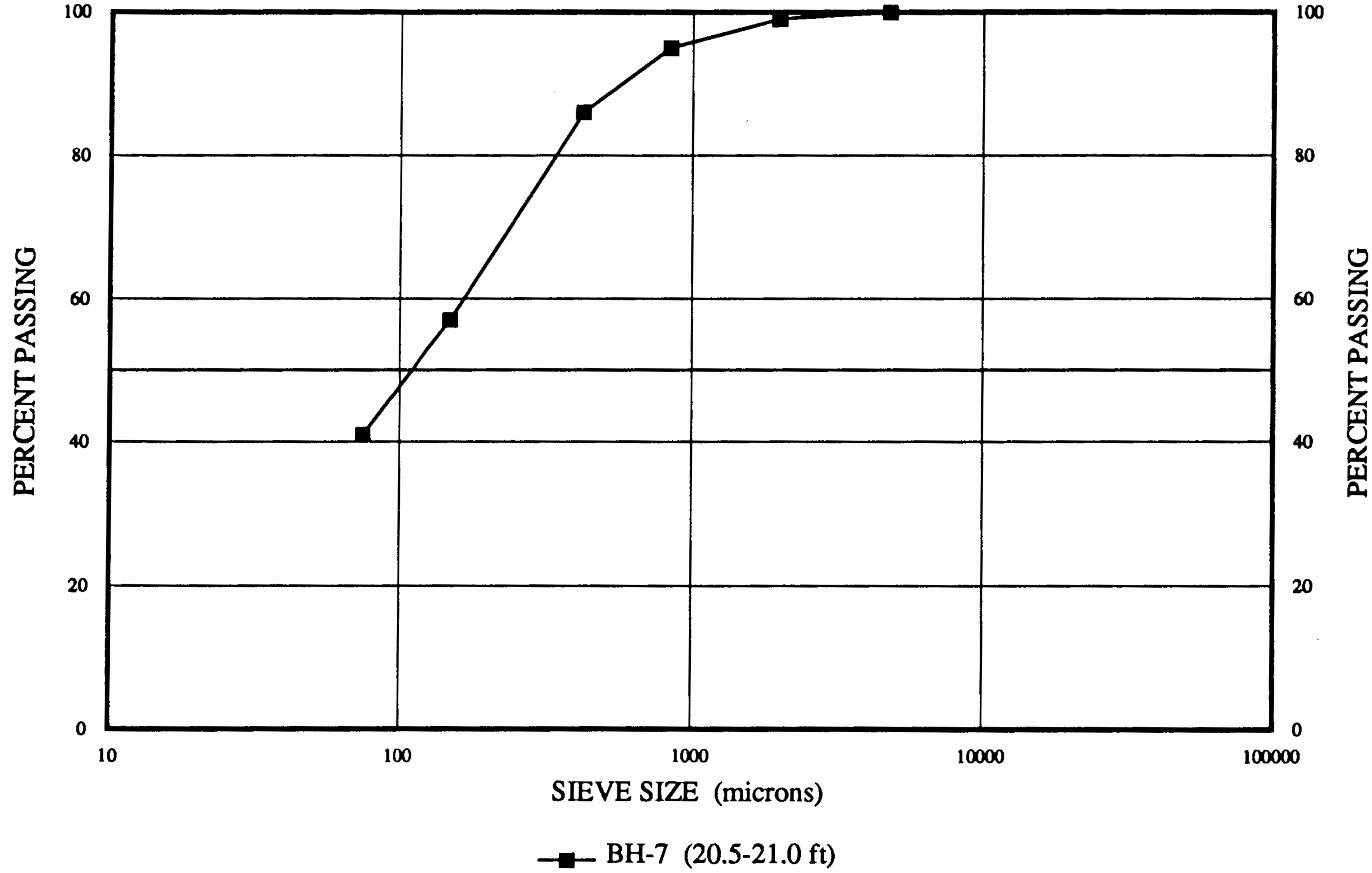
Bermite Division, Whittaker Corporation



FROM SOIL BORINGS COMPLETED JULY 1987

GRAIN SIZE ANALYSIS

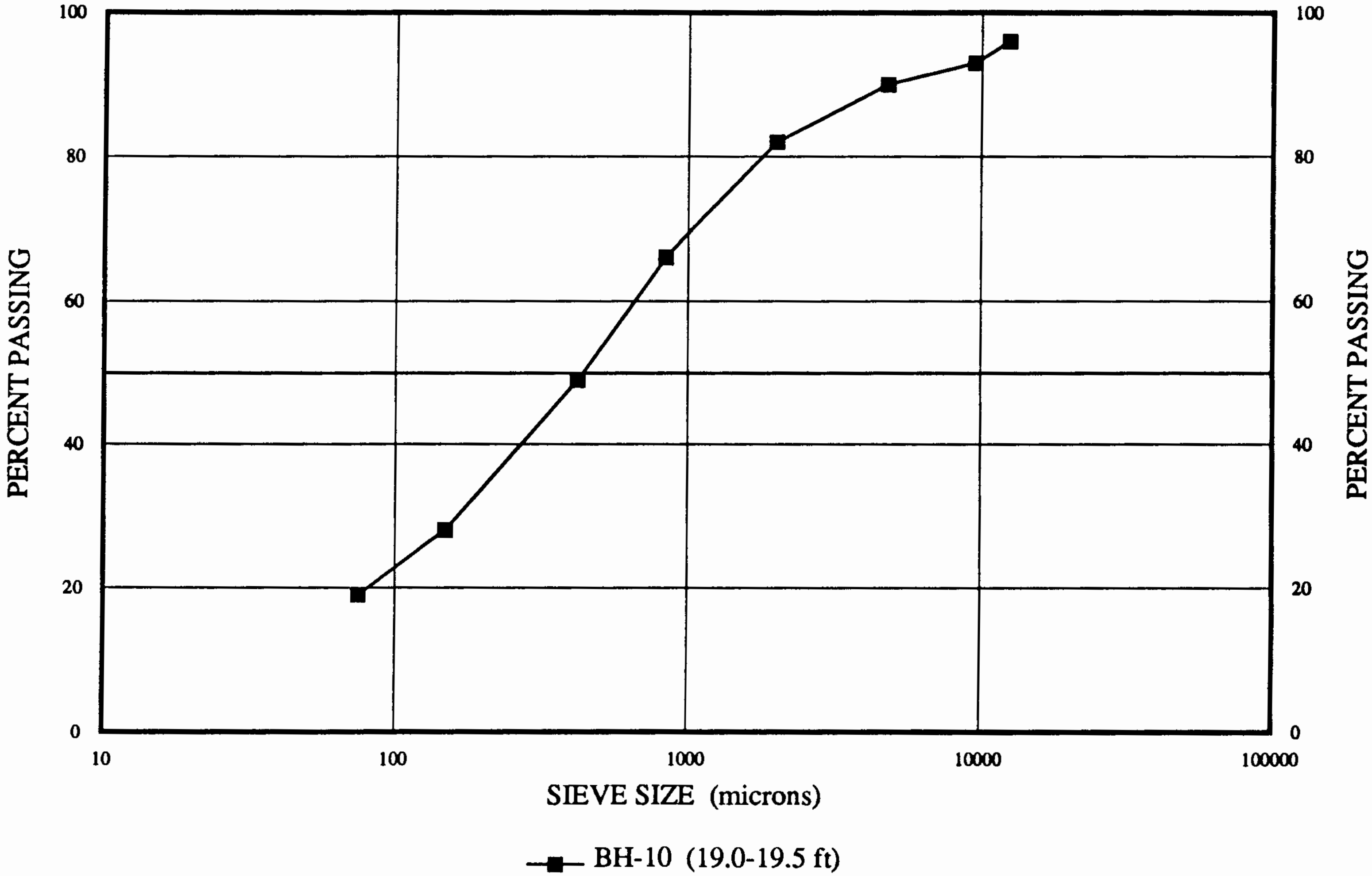
Bermite Division, Whittaker Corporation



FROM SOIL BORINGS COMPLETED JULY 1987

GRAIN SIZE ANALYSIS

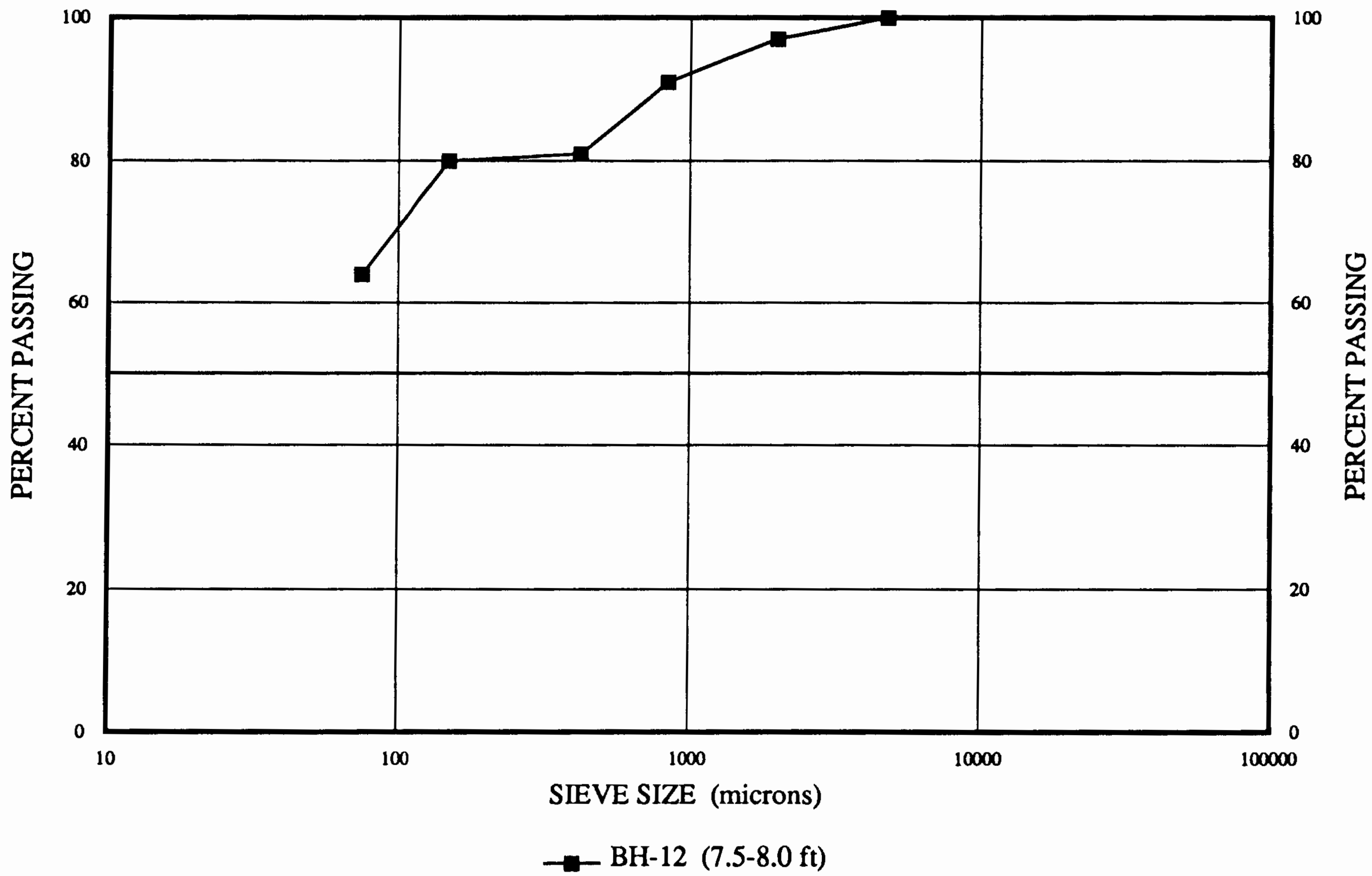
Bermite Division, Whittaker Corporation



FROM SOIL BORINGS COMPLETED JULY 1987

GRAIN SIZE ANALYSIS

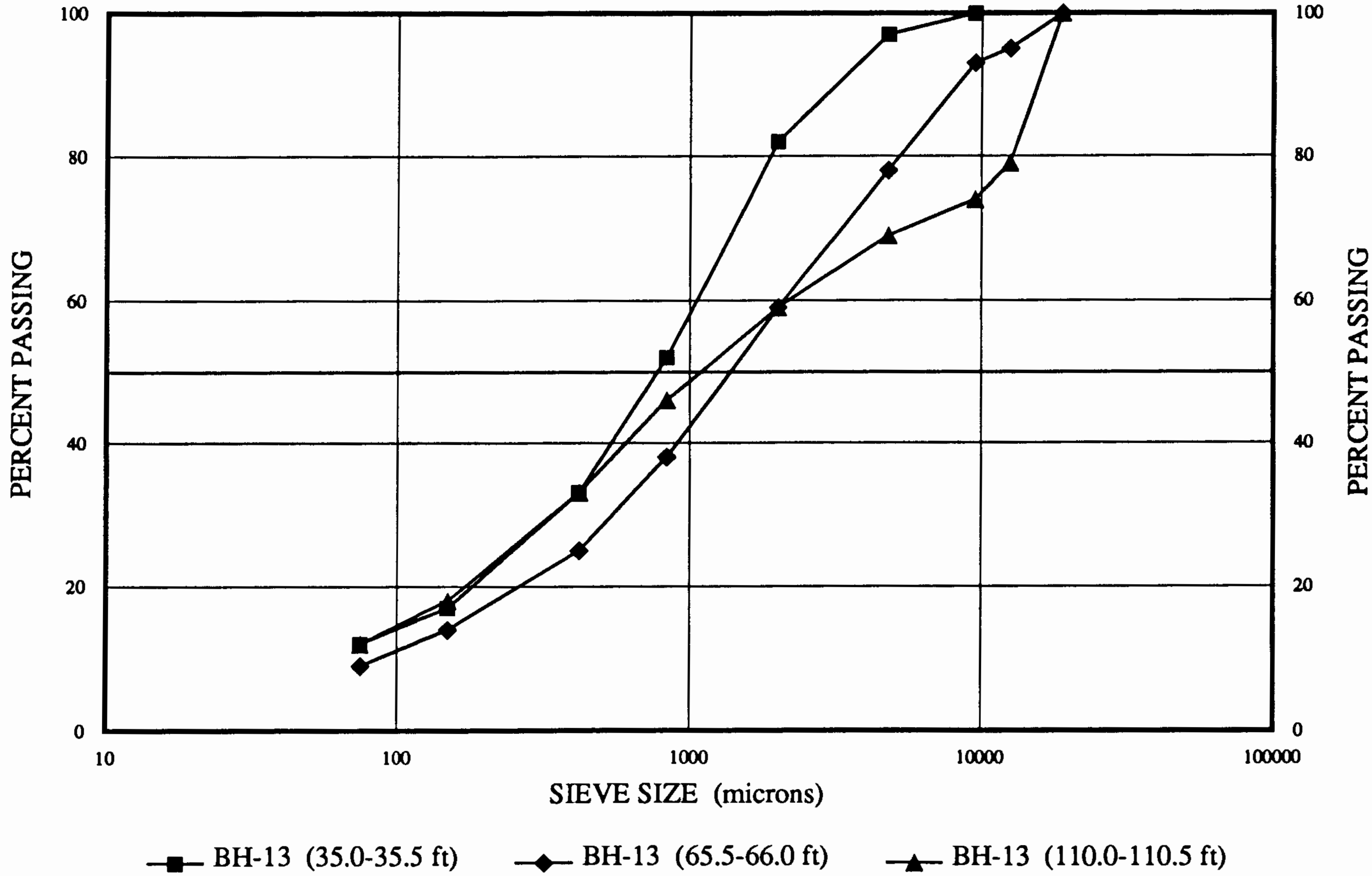
Bermite Division, Whittaker Corporation



FROM SOIL BORINGS COMPLETED JULY 1987

GRAIN SIZE ANALYSIS

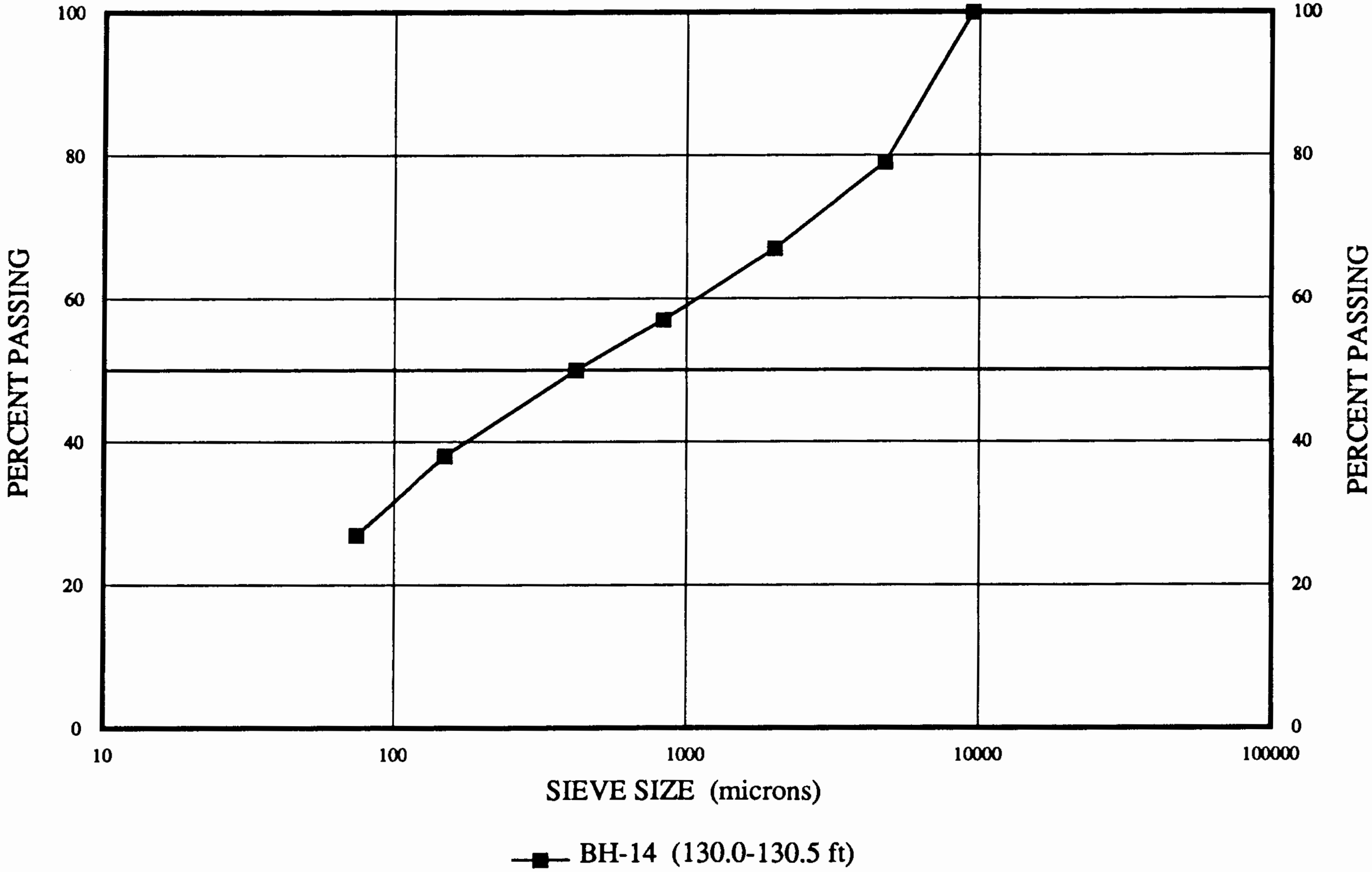
Bermite Division, Whittaker Corporation



FROM SOIL BORINGS COMPLETED JULY 1987

GRAIN SIZE ANALYSIS

Bermite Division, Whittaker Corporation



FROM SOIL BORINGS COMPLETED JULY 1987

APPENDIX D

GEOLOGIST LOGS

FROM CONSTRUCTION OF GROUNDWATER MONITORING WELLS

MW-1 THROUGH MW-6

WAI Job No.: 85-01.4

Project: BERMITE

Consulting Engineers
Wenck Associates, Inc.
Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Log of: WELL W-1

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
	SANDY CLAY, SOME GRAVEL, BROWN TO BEIGE COLOR, VERY HARD		WASH	
25				
50	SAND & GRAVEL	COARSE ALLUVIUM	WASH	
75	CLAYEY SAND, SMALL % OF GRAVEL	COARSE ALLUVIUM	WASH	SHORT SOLID LINE INDICATES A MATERIAL SIZE CHANGE AND/OR CLAY CONTENT. SAME FORMATION, MINOR CHANGES.

	Date	Time	Water Level	Casing Depth	Screen Interval
Drilling Company: TRUDELL DRILLING					
Starting Date: 12/8/87			429 T.O.C.	638'	638'-658'
Completion Date: 12/19/87					
Depth of Well: 658'					
Drilling Method: AIR ROTARY, MUD ROTARY					
Surface Elevation: 1535.5					
Top of Casing: 1538.06					
Water Table Elevation: N/A					
Logged by: GREGORY W. SMITH					

Note: Refer to the attached sheets for an explanation of terminology on this log.

WAI Job No.: 85-014 Project: BERMITE	Wenck Associates, Inc. Consulting Engineers Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391 Vertical Scale: 1"=15'	Page 2 of 6 Log of: WELL W-1

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
100				
125				
150	MEDIUM TO COARSE SAND & GRAVEL, NOT AS MUCH CLAY AS PREVIOUS (POORLY SORTED) VERY LITTLE CLAY, SOME SILT IN SAMPLES.	COARSE ALLUVIUM	WASH	
175				
200				

WAI Job No.: 85-01.4	Consulting Engineers Wenck Associates, Inc. Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391	Page 3 of 6
Project: Bermite	Vertical Scale: 1"=15'	Log of: Well W-1

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
225				
250				
275		Coarse Alluvium		No true formation chg. throughout boring. The only variation is in size and clay content with random boulders
300	Material same as previous, clay content is higher than previous. Actually clay content varies throughout. Generally streaky with places of ≈2'-5' beds.		Wash	
325				

WAI Job No.: 85-01.4

Project: BERHITE

Consulting Engineers

Wenck Associates, Inc.

Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Log of: WELL W-1

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
350				
375				
400				
	SANDY CLAY, CLAY CONTENT QUITE HIGH. SAND SIZE GENERALLY FINE TO MEDIUM.		WASH	
425				STATIC WATER LEVEL AT APPROX. 429.
450				

WAI Job No.: 85-01.4	Wenck Associates, Inc. Consulting Engineers Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391	Page 5 of 6
Project: BERMITE	Vertical Scale: 1"=15'	Log of: WELL W-1

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
475				
	SORTING VARIES WITH DEPTH, CLAY CONTENT TENDS TO BE FAIRLY HIGH, PROBABLY THIN STREAKS, SOME ~~LA~~ THICKER BEDS, GENERALLY STREAKY. NOT MUCH GRAVEL SIZE VARIES FROM MED. SAND & GRAVEL.	COARSE ALLUVIUM	WASH	
500				
	BOULDERS FROM 510' TO 540'.			
525				
550				
	CLAY IS BEGINNING TO DECREASE, MED TO COARSE SAND WITH SOME GRAVEL.	COARSE ALLUVIUM	WASH	
575				

WAI Job No.: 85-01.4

Project: BERMITE

Consulting Engineers

Wenck Associates, Inc.

Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Log of: WELL W-1

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
600				NO TRUE FORMATION CHANGE THROUGHOUT BORING THE ONLY VARIATION IS IN PARTICLE SIZE AND CLAY CONTENT. WITH RANDOM BOULDERS.
625				
650	WATER BEARING FORMATION, MED. TO COARSE SAND, SOME FINES IN MATERIAL			APPROXIMATE LOCATION OF WATER BEARING FM.
658'	END OF BORING			

Wenck Associates, Inc.

GEC JOB NO: ____________ LOG OF BORING NO. WELL W-2

PROJECT: BERMITE DIVISION - WHITTAKER CORPORATION

WCCC

DEPTH, IN FEET	SURFACE ELEVATION: IDENTIFICATION	GEOLOGY	N BPF	WB	SAMPLE TYPE	REC.	MC	DEN	L.L./P.L.	qc
	CLAYEY SAND, SMALL % OF GRAVEL, BUFF OR LT TAN IN COLOR				WASH					
25'										
50'	POORLY SORTED GRAVEL AND SAND	COARSE ALLUVIUM			WASH					
75'										
	VERY COARSE SAND AND GRAVEL WITH VARYING %'S OF CLAY. CLAY TENDS TO BE STREAKY	COARSE ALLUVIUM			WASH					
100'										

DEPTH	DRILLING METHOD	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
480'	AIR-ROTARY							
	MUD-ROTARY	11/18/87						
							STATIC-	325'
BORING COMPLETED:		11/23/87					WATER BEARING STRATA	452'
CC: CA: Rig:								

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

11/85

WENCK ASSOCIATES, INC.

JOB NO: ______________

VERTICAL SCALE: 1″=15′

LOG OF BORING NO.

P..JECT: ______________

DEPTH, ft	DESCRIPTION AND CLASSIFICATION	GEOLOGY	N	WB	SAMPLE TYPE	REC.	FIELD & LABORATORY TESTS MC	DEN	L.L. / P.L.	
125′										
	At 135′ sample contains a higher % of clay. Poorly sorted very coarse sand and gravel.	Alluvium			Wash					
150′										
175′										
200′										
	Well sorted very coarse sand, minor % of clay in sample	Coarse Alluvium			Wash					
225′										

WENCK ASSOCIATES, INC.

JOB NO: ____________

VERTICAL SCALE: 1"=~~2'~~ 15'

LOG OF BORING NO.

PROJECT: ____________

DEPTH, FEET	DESCRIPTION AND CLASSIFICATION	GEOLOGY	N	WB	SAMPLE TYPE	REC.	FIELD & LABORATORY TESTS: MC	DEN	L.L./P.L.	
[illegible]										
	COARSE SAND, WELL SORTED	ALLUVIUM			WASH					
[illegible]										
[illegible]										
[illegible]										
[illegible]										

WENCK ASSOCIATES, INC.

JOB NO: VERTICAL SCALE: 1"=~~2'~~ 15' LOG OF BORING NO.

PROJECT:

DEPTH, in FT	DESCRIPTION AND CLASSIFICATION	GEOLOGY	N	WB	SAMPLE TYPE	REC.	FIELD & LABORATORY TESTS MC	DEN	L.L. / P.L.	
385'										
	VERY COARSE MODERATE TO WELL-SORTED SAND	ALLUVIUM			WASH					
400'										
	HIT HARD CONSOLIDATED MATERIAL, CUTTINGS FROM A GRANITE BOULDER. WAS 15'-18' THICK	BOULDER			WASH					
4[illegible]'										
	438' INTO A WELL SORTED QTZ SAND, MEDIUM TO COARSE	ALLUVIUM			WASH					
4[illegible]'										
	WATER TABLE ▼									
4[illegible]'										
	END OF DRILLING									
495'										

WAI Job No.: 85-01.4	Consulting Engineers Wenck Associates, Inc. Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391	Page 1 of 6
Project: BERMITE	Vertical Scale: 1"=15'	Log of: WELL W-3

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
	CLAY, BROWN			
6				
25				
	SANDY CLAY, VERY FINE TO FINE SAND	ALLUVIUM	WASH	
50				
	POORLY SORTED SAND & GRAVEL, SOME CLAY WHICH APPEARS TO BE STREAKY, (THIN BEDS) AT TIMES THERE IS ENOUGH CLAY TO BALL UP ON BIT AND SLOW DOWN DRILLING.			
75		COARSE ALLUVIUM	WASH	SORTING AND CLAY CONTENT VARYING WITH DEPTH. NO FORMATION CHANGES, JUST SIZE AND CLAY CONTENT VARIATIONS.

	Date	Time	Water Level	Casing Depth	Screen Interval	
Drilling Company: TRUDELL DRILLING						Note: Refer to the attached sheets for an explanation of terminology on this log.
Starting Date: 1/8/88			452' T.O.C.	676'	676'-696'	
Completion Date: 11/13/88						
Depth of Well: 707'						
Drilling Method: AIR ROTARY, MUD ROTARY						
Surface Elevation:						
Top of Casing:						
Water Table Elevation: N/A						
Logged by: GREGORY W. SMITH						

WAI Job No.: 85-014	Consulting Engineers Wenck Associates, Inc. Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391	Page 2 of 6
Project: BERMITE	Vertical Scale: 1"=15'	Log of: WELL W-3

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
100				60'-210', SAME OR SIMILAR MATERIAL
125		COARSE ALLUVIUM		
150				HIT BOULDER AT 150', JUST A FEW ~~FT~~ FEET THICK. FROM HERE TO ABOUT ~~TO~~ 680' BOULDERS WILL BE RANDOM
175				
200				
	BOULDER			LARGE BOULDER AT 210'-220'

ter

WAI Job No.: 85-01.4

Project: BERMITE

Wenck Associates, Inc. — Consulting Engineers
Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Page 3 of 6

Log of: WELL W-3

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
225	POORLY SORTED SAND & GRAVEL, CLAY CONTENT STILL QUITE HIGH BUT DECREASING WITH DEPTH	COARSE ALLUVIUM	WASH	
	WELL SORTED MEDIUM SAND.			
250		COARSE ALLUVIUM	WASH	SAND & GRAVEL (MINOR) THROUGHOUT, VARYING DEGREES OF SORTING
275				
	MEDIUM TO COARSE SAND, SORTING FROM MEDIUM TO WELL.	COARSE ALLUVIUM	WASH	
300				
325				

WAI Job No.: 85-014	Wenck Associates, Inc. Consulting Engineers, Twelve Oaks Center, 15500 Wayzata Blvd., Wayzata, MN 55391	Page 4 of 6
Project: BERMITE	Vertical Scale: 1"=15'	Log of: WELL W-3

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
350				
	POORLY SORTED SAND, SOME GRAVEL. STREAKS OF CLAY.	COARSE ALLUVIUM	WASH	DRILLING MUD SHOWS THICKENING, MEANING PRESENCE OF CLAY
375				
400				
425	SANDY CLAY, VERY HIGH % OF CLAY (SHALE), SOME FINE TO MED. SAND PRESENT IN SAMPLE, VERY SMALL AMOUNT	FINE ALLUVIUM	WASH	FROM 420' TO ABOUT 465' DRILLER HAD TO HOLD BACK ON DRILL PIPE, PENETRATION WAS TOO HIGH. COULDN'T KEEP BIT CLEAN AS WELL AS THE HOLE.
450				STATIC WATER LEVEL AT ABOUT 452'
	BOULDERS AND CLAY, SAMPLE			

ter

WAI Job No.: 85-01.4

Project: BERMNE

Consulting Engineers
Wenck Associates, Inc.
Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Log of: WELL W-3

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
475	CONTAINS CUTTINGS AND CLAY CUTTINGS FROM HARD ROCK, FINE AND SHARP.		WASH	DRILLS LIKE A BOULDER FOR A FEW FEET THEN DROPS A FEW FEET UNTIL IT HITS ANOTHER BOULDER.
500	VERY POORLY SORTED, SAND & GRAVEL, CLAY NOTICEABLE AT TIMES, GENERALLY STREAKY	COARSE ALLUVIUM	WASH	
525	CLAY, SOME SAND, VERY MINOR, DRILLED VERY QUICKLY.	FINE ALLUVIUM	WASH	
550	VERY POORLY SORTED, SAND & GRAVEL, CLAY NOTICEABLE AT TIMES, GENERALLY STREAKY	COARSE ALLUVIUM	WASH	
575				

ter

WAI Job No.: 85-01.4

Project: BERMITE

Consulting Engineers

Wenck Associates, Inc.

Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Log of: WELL W-3

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
				FROM 590-600', REDRILLING SHOWED CLAY OR WASHOUT, STEM WENT DOWN QUICKLY.
600		COARSE ALLUVIUM		AT 610' A TRACE OF CRUDE OIL ON SURFACE OF DRILLING FLUID COMING OUT OF HOLE.
625				
650	BOULDER			
	COARSE SAND & SOME CLAY (STREAKY) BOULDERS (RANDOMLY)	COARSE ALLUVIUM	WASH	
675				
	CUTTINGS ARE A VERY COARSE SAND TO FINE GRAVEL, SHARP (VERY FEW ROUNDED EDGES) DRILLING AT ABOUT 20' . AN HOUR. DON'T APPEAR TO BE CUTTINGS FROM A CONSOLIDATED MATERIAL (ROCK OR BOULDER)	BEDROCK (SEE TERMINOLOGY SHEET)	WASH	DRILLING BECOMES VERY SLOW AT 683'. CUTTINGS ARE QUITE LARGE AND SHARP, MUST BE WELL CEMENTED
700	WATER ZONE.			APPROXIMATE LOCATION OF WATER BEARING FM.
707	END OF BORING			

WAI Job No.: 85-01.4

Project: BERMITE

Consulting Engineers

Wenck Associates, Inc.

Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Page 1 of 2

Log of: WELL W-4

Depth In Feet	Description and Classification	Geology	Sample type	Remarks
	HARD CLAY, SOME SAND & GRAVEL	ALLUVIUM	WASH	
20'				
50'	SILTY SAND & GRAVEL	FINE-COARSE ALLUVIUM	WASH	RANDOM BOULDERS

	Date	Time	Water Level	Casing Depth	Screen Interval
Drilling Company: AQUA DRILLING					
Starting Date: 7/21/88					
Completion Date: 7/25/88					
Depth of Well: 699'					
Drilling Method: AIR ROTARY					
Surface Elevation:					
Top of Casing: 1537.92					
Water Table Elevation: N/A					
Logged by: GREGORY W. SMITH					

Note: Refer to the attached sheets for an explanation of terminology on this log.

WAI Job No.: 85-131A	Consulting Engineers Wenck Associates, Inc. Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391	Page 2 of 6
Project: BERAITE	Vertical Scale: 1"=15'	Log of: WELL W-4

Depth In Feet	Description and Classification	Geology	Sample type	Remarks
100'				
	SAND & GRAVEL, RANDOM BOULDERS	COARSE ALLUVIUM	WASH	BOULDERS BETWEEN 108' AND 112' BOULDER AT 135' CLAY BEGINNING TO SHOW AROUND 120'-130' BOULDER AT 145'
150'				
	SANDY CLAY	FINE ALLUVIUM	WASH	HIGH %. OF CLAY BETWEEN 190'-200'
200'				

WAI Job No.: 85-014	Consulting Engineers Wenck Associates, Inc. Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391	Page 3 of 6
Project: BERMITE	Vertical Scale: 1"=15'	Log of: WELL W-4

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
	SANDY CLAY	FINE ALLUVIUM	WASH	
250'				BOULDER AT 255'
	SAND & GRAVEL	COARSE ALLUVIUM	WASH	BOULDER AT 285'
300'	SANDY CLAY	FINE ALLUVIUM	WASH	

WAI Job No.: 85-014	Wenck Associates, Inc. Consulting Engineers Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391	Page 4 of 6
Project: [illegible]	Vertical Scale: 1"=15'	Log of: Well W-4

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
				Boulder at 355'
360'				
	Sand & gravel, minor clay	Coarse alluvium	Wash	
400'				
	Sandy clay	Fine alluvium	Wash	
				Boulder at 450'
460'				
				Boulder at 465'

WAI Job No.: 85-31.4

Project: BERNITE

Wenck Associates, Inc. Consulting Engineers
Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Page 5 of 6

Log of: WELL W-4

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
	CLAYEY SAND, % OF CLAY VARIABLE	COARSE ALLUVIUM	WASH	
500'				
				BOULDER AT 525'
550'				
				BOULDER AT 576'

WAI Job No.: 85 014	Wenck Associates, Inc. Consulting Engineers, Twelve Oaks Center, 15500 Wayzata Blvd., Wayzata, MN 55391	Page 6 of 6
Project: Brennin	Vertical Scale: 1"=15'	Log of: Well W-4

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
600'				
	CLAYEY SAND	COARSE ALLUVIUM	WASH	
650'				
	SAND & GRAVEL, TRACES OF CLAY	COARSE ALLUVIUM	WASH	
				APPEARS TO BE A SHALE BED AT 690', DETERMINED BY RATE OF PENETRATION
				BOULDER AT 692'
700'	END OF BORING			

WAI Job No.: 85-01.4

Project: BERNITE

Consulting Engineers

Wenck Associates, Inc.

Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Page 1 of 3

Log of: MW-5

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
	HARD CLAY, SOME SAND & GRAVEL	ALLUVIUM	GRAB	
50'	GRAVEL & COBBLES, SOME CLAY			RANDOM BOULDERS
100'				
150'				
	SAND & GRAVEL, CLAY CONTENT INCREASING IN SAMPLE	ALLUVIUM		

	Date	Time	Water Level	Casing Depth	Screen Interval
Drilling Company: BEYLIK					
Starting Date: JULY 7, 1989					
Completion Date: JULY 10, 1989					
Depth of Well: 663 FEET					
Drilling Method: MUD ROTARY					
Surface Elevation: 1490.5					
Top of Casing: 1493.38					
Water Table Elevation: N/A					
Logged by: GREGORY W. SMITH					

Note: Refer to the attached sheets for an explanation of terminology on this log.

WAI Job No.: 85-01.4

Project: BERNATG

Wenck Associates, Inc.
Consulting Engineers
Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Page 2 of 3

Log of: MW-5

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
100'				
200'	SMALL SHARP CUTTINGS, NOT ROUNDED, ABOUT THE SIZE OF COARSE SAND. NO CLAY. APPEARS TO BE CONSOLIDATED SAND (SANDSTONE)			SLOW, HARD DRILLING 200-220' WAS MOSTLY BOULDERS
250'				
300'				
50'	SMALL SHARP CUTTING, HAS BEEN NO REAL CHANGE IN CUTTINGS EXCEPT FOR CLAY CONTENT.			STILL SLOW, HARD DRILLING.
30'				

Wenck Associates, Inc. — Consulting Engineers
Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

WAI Job No.: 85-01.4

Project: BERNITE

Vertical Scale: 1"=15'

Page 3 of 3

Log of: MW-5

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
				FREQUENT BOULDERS BETWEEN 440'-460'.
450'				
				BOULDERS ARE NO LONGER PRESENT.
500'	STILL SMALL SHARP CUTTINGS THAT BEGAN AT ABOUT 200'. CLAY CONTENT BEGINNING TO INCREASE.	ALLUVIUM		
550'	CLAY STILL INCREASING, STRINGERS OF CLAY APPEAR TO BE 3'-5' THICK. SHARP CUTTINGS (TYPICAL)			
	A LOT OF CLAY AT ABOUT 550'-560' VERY LITTLE MATERIAL IN CUTTINGS, RETURNING TO SURFACE.			
600'				DRILLING MUD IS BEGINNING TO GET THICKER FROM NATURAL CLAYS.
	SANDY CLAY, HIGH CLAY CONTENT. MED-COARSE SAND	ALLUVIUM		CLAYS ARE BEGINNING TO STICK TO BOREHOLE WALL. SOME SAND SHOWING AROUND 620'.
	FINE TO MED SAND IN SAMPLE,			
650'				MUD BEGAN TO THIN WHILE DRILLING 640'-660' INTERVAL.
	END OF BORING AT 663'.			

WAI Job No.: 85-01.4 Project: BERHITE	Consulting Engineers Wenck Associates, Inc. Twelve Oaks Center 15500 Wayzata Blvd. Wayzata, MN 55391 Vertical Scale: 1"=15'	Page 1 of 4 Log of: MW-6

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
	SAND & GRAVEL WITH CLAY	ALLUVIUM	GRAB	RANDOM BOULDERS
50'				
100'	POORLY SORTED SAND WITH SOME GRAVEL, HIGH CLAY CONTENT SANDY CLAY	ALLUVIUM	GRAB	
150'				BOULDERS BETWEEN 170'-180'

	Date	Time	Water Level	Casing Depth	Screen Interval	
Drilling Company: BEYLIK DRILLING						Note: Refer to the attached sheets for an explanation of terminology on this log.
Starting Date: JUNE 23, 1989						
Completion Date: JUNE 29, 1989						
Depth of Well: 697 FEET						
Drilling Method: MUD ROTARY						
Surface Elevation: 1518.4						
Top of Casing: 1521.14						
Water Table Elevation: N/A						
Logged by: GREGORY W. SMITH						

WAI Job No.: 85-01.4

Project: BERMITE

Consulting Engineers

Wenck Associates, Inc.

Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Page 2 of 4

Log of: MW-6

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
200'	SAND & GRAVEL, MINOR CLAY	ALLUVIUM	GRAB	BOULDERS BETWEEN 230'-240'
250'				
300'	MED. TO COARSE SAND, HIGH CLAY CONTENT SANDY CLAY	ALLUVIUM		CLAY IS PROBABLY IN BEDS OR STRINGERS. MATERIAL IS MIXING COMING UP HOLE. DRILLING MUD IS THICKENING WITH NATURAL CLAYS
350'				
	GRAVEL		GRAB	
400'	SHARP ROCK CHIPS (CUTTINGS)			DRILLING ALOT OF BOULDERS HIGH CLAY BETWEEN 420'-440'

WAI Job No.: 85-01.4

Project: BERMITE

Consulting Engineers
Wenck Associates, Inc.
Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Log of: MW-6

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
450'	MED TO COARSE SAND, CLAY IS VARIABLE BUT TYPICALLY QUITE HIGH.			RANDOM BOULDERS
500'				CLAY IS VERY HIGH AT TIMES
550'				BOULDERS BETWEEN 575'-580'
600'	CLAY CONTENT IS INCREASING WITH DEPTH.			
650'				

WAI Job No.: 85-01.4

Project: BERMITE

Consulting Engineers

Wenck Associates, Inc.

Twelve Oaks Center
15500 Wayzata Blvd.
Wayzata, MN 55391

Vertical Scale: 1"=15'

Page 4 of 4

Log of: MW-6

Depth in Feet	Description and Classification	Geology	Sample type	Remarks
				SAMPLE WAS 100% ± CLAY AT 670'
				SOME SAND IN SAMPLE AT 680'.
700'	END OF BORING			NORMAL CHANGE IN SAMPLES FROM 440' TO THE END OF BORING

APPENDIX E

WIRELINE ELECTRIC LOGS

OF GROUNDWATER MONITORING WELLS

MW-1 THROUGH MW-6

APPENDIX F

OIL WELL DATA

FROM OIL WELLS AT AND NEAR

THE BERMITE FACILITY

FORM 1672

Page 5

COMPANY GENERAL PETROLEUM CORP. LEASE Bermite #1 (P17) WELL NO.

ELEVATION 1494.38' k.b. LOCATION: 290.01' W'ly along N'ly line Bermite Lease from NE corner thence 330.22' S'ly at right angles.

SPUDDED February 25, 1950 ~~COMPLETED~~ Abandoned: April 14, 1950

DIVISION OF OIL & GAS
RECEIVED
APR 7 1951
LOS ANGELES

TOP	BOTTOM	REC'Y	FORMATION
0	231		Sand and gravel
231	328		Boulders and gravel
328	507		Sand, clay and gravel
507	786		Shale and hard sand
786	819		Shale
819	902		Shale with streaks hard sand
902	1073		Sand and streaks shale
1073	1236		Boulders, sand and clay
1236	1451		Hard sand and streaks shale
1451	1496		Hard sand
1496	1502		Hard sand and shale
1502	1728		Hard sand
1728	1803		Hard sand, conglomerate and shale
1803	1904		Sand
1904	2221		Hard sand and streaks shale
2221	2318		Sand and shale
2318	2405		Hard sand and streaks shale
2405	2478		Sand and shale, streaks conglomerate
2478	2581		Shale with hard sand
2581	2689		Hard sand and conglomerate
2689	2776		Sand and shale
2776	2881		Hard sand and streaks shale
2881	2955		Hard sand and conglomerate
2955	3280		Sand and shale
			CORE #1 3280/3300' Rec. 20'
3280	3281	1'	CONGLOMERATE, grey-green, green clay matrix with rounded pebbles up to 1/2" diameter, poorly sorted, massive, friable, low K appearance, no cut, stain or odor, probably wet.
3281	3300	19	SILTSTONE, grey-green, clayey, with scattered coarse sand grains grading locally to fine-medium grained clayey SAND, massive, fairly firm, friable, low to fair K, no cut, stain or odor.
			CORE #2 3300/3325' Rec. 25'
3300	3304	4'	SILTSTONE, grey-green, as above
3304	3324	20	CONGLOMERATE, as above with pebbles up to 3" in diameter, fresh and rounded to highly weathered, sub-angular in soft green clay matrix, massive, easily friable, low to fair K, no cut, stain or odor, wet.
3324	3325	1'	SILTSTONE, as above.

FORM 101
CALIFORNIA STATE PRINTING OFFICE

SUBMIT IN DUPLICATE

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

DIVISION OF OIL AND GAS

RECEIVED AUG 25 19.9 LOS ANGELES, CALIFORNIA

Now Terminal-McBurney,
Terminal Drilling Company

LOG AND CORE RECORD OF OIL OR GAS WELL

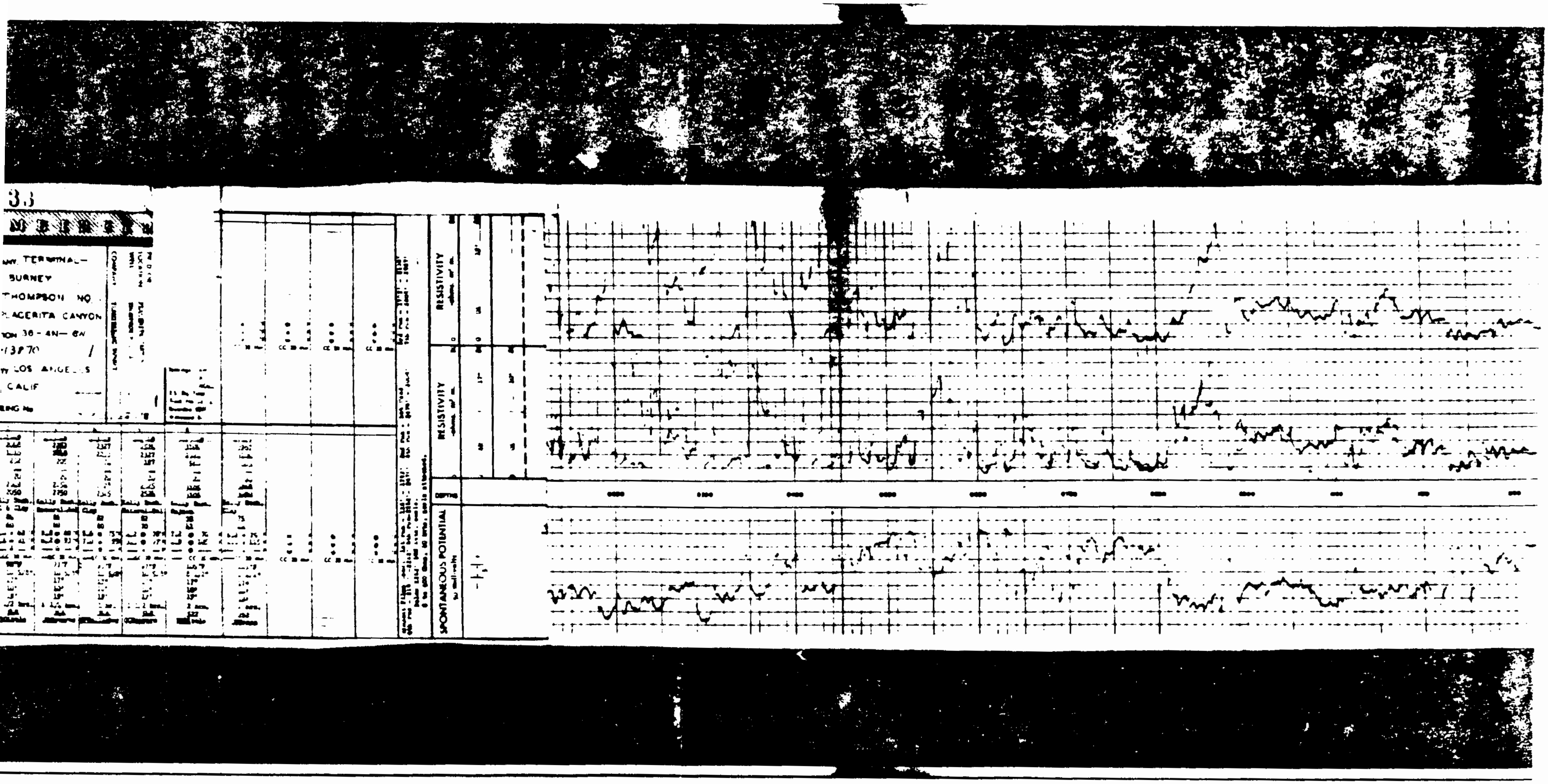
Operator (Rothschild Oil Company) Field Placerita

EB

Well No. Thompson #1 Sec. 36, T. 4 N, R. 16 W, S.B. & B. & M.

FORMATIONS PENETRATED BY WELL

DEPTH TO		Thickness	Drilled or Cored	Recovery	DESCRIPTION
Top of Formation	Bottom of Formation				
0'	152'		Drilled		Surface sand
152'	372'		"		Sand and gravel
72'	441'		"		Sand and clay
41'	724'		"		Sand and gravel
724'	794'		"		Blue Shale ←
794'	941'		"		Hard sand
41'	1228'		"		Hard sand
1228'	1350'		"		sand w/streaks blue shale
1350'	1536'		"		Shale w/streaks sand
1 36'	1699'		"		Blue sand
1 99'	1862'		"		Hard sand
1862'	1941'		"		Hard sand
1 41'	2050'		"		Blue shale
2 50'	2250'		"		Blue shale w/streaks sand
2250'	2412'		"		Hard sand
2412'	2524'		"		Shale and sand.



33
THOMPSON NO.
PLACERITA CANYON
LOS ANGELES
CALIF
RESISTIVITY
RESISTIVITY
DEPTHS
SPONTANEOUS POTENTIAL

Frui~ Growers Laborato~, Inc.

P. O. BOX 272 · 853 CORPORATION STREET · PHONE (805) 525-3824
659-0910

WATER ANALYSIS REPORT

OWNER — JMT Oil Company

DATE SUBMITTED — March 10, 1986

SAMPLER —

ANALYSIS REPORTED — March 21, 1986

LAB. NO. — 79608-8

MATERIAL Santa Fe Minerals S-16
Sampled: 3/5/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%		MILLIGRAMS PER LITER
Calcium (Ca)	5	100	2.3	Boron	84
Magnesium (Mg)	2	19	0.9	Fluoride	
Sodium (Na)	204	4700	95.8	Iron	8.7
Potassium (K)	2	90	0.9	Manganese	0.96
Carbonate (CO_3)	None detected			MBAS	
Bicarbonate (HCO_3)	51	3111	24.4	Copper	
Chloride (Cl)	158	5600	75.6	Zinc	
Sulphate (SO_4)	None detected			Arsenic	
Nitrate (NO_3)				Barium	1.3
Nitrate-N (NO_3-N)				Cadmium	
Total Hardness (as $CaCO_3$)		350		Chromium	
				Lead	
				Mercury	
				Selenium	
				Silver	

Total Dissolved Solids 1. Summation 13620 2. Residue @ 180°

pH 7.5
EC X 10^{-6} @ 25° C 18933
SAR

These results were obtained by following standard laboratory procedures the liability of the corporation shall not exceed the amount paid for this report.

Chemist

Ming Y. Wang

Fruit Growers Laboratory, Inc.

P. O. BOX 272 · 853 CORPORATION STREET · PHONE (805) 525-3824
659-0910

WATER ANALYSIS REPORT

OWNER JMT Oil Company

DATE SUBMITTED March 10, 1986

SAMPLER –

ANALYSIS REPORTED – March 21, 1986

LAB. NO. – 79608-7

MATERIAL Union Oil Company/ Del Auso Lease
Sampled: 3/7/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%		MILLIGRAMS PER LITER
Calcium (Ca)	6	120	7.1	Boron	28
Magnesium (Mg)	5	60	5.9	Fluoride	
				Iron	0.1
Sodium (Na)	74	1700	87.1	Manganese	0.16
Potassium (K)		10		MBAS	
Carbonate (CO_3)	None detected			Copper	
				Zinc	
Bicarbonate (HCO_3)	7	427	8.1	Arsenic	
Chloride (Cl)	79	2800	91.9	Barium	0.8
				Cadmium	
Sulphate (SO_4)	None detected			Chromium	
Nitrate (NO_3)				Lead	
				Mercury	
Nitrate-N (NO_3-N)				Selenium	
Total Hardness (as $CaCO_3$)		550		Silver	
Total Dissolved Solids	1. Summation	5117		2. Residue @ 180°	

pH 7.6
EC X 10^6 @ 25° C 7745
SAR

These results were obtained by following standard laboratory procedures: the liability of the corporation shall not exceed the amount paid for this report

Chemist
Ming Y. Wang

Fruit Growers Laboratory, Inc.

P. O. BOX ... – 853 CORPORATION STREET – PHONE (...) 525-3824
659-0910

WATER ANALYSIS REPORT

OWNER – JMT Oil Company

DATE SUBMITTED – March 10, 1986

SAMPLER –

ANALYSIS REPORTED – March 21, 1986

LAB. NO. – 79608-6

MATERIAL Elmtree Oil Company/Rogers #1/Martinez Canyon
Sampled: 3/6/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%	MILLIGRAMS PER LITER	
Calcium (Ca)	5	100	1.5	Boron	76
Magnesium (Mg)	4	44	1.2	Fluoride	
Sodium (Na)	313	7200	96.9	Iron	4.5
Potassium (K)	1	30	0.3	Manganese	0.17
Carbonate (CO_3)	None detected			MBAS	
Bicarbonate (HCO_3)	13	793	4.0	Copper	
Chloride (Cl)	310	11000	96.0	Zinc	
Sulphate (SO_4)	None detected			Arsenic	
Nitrate (NO_3)				Barium	3.0
Nitrate-N (NO_3-N)				Cadmium	
Total Hardness (as $CaCO_3$)		450		Chromium	
				Lead	
				Mercury	
				Selenium	
				Silver	

Total Dissolved Solids 1. Summation 19167 2. Residue @ 180°

pH 7.7
EC X 10^{-6} @ 25° C 28400
SAR

These results were obtained by following standard laboratory procedures the liability of the corporation shall not exceed the amount paid for this report.

Chemist

Ming Y. Wang

Fruit Growers Laboratory, Inc.

P. O. BOX 272 – 853 CORPORATION STREET   PHONE (805) 525-3824
659-0910

WATER ANALYSIS REPORT

OWNER JMT Oil Company

DATE SUBMITTED March 10, 1986

SAMPLER —

ANALYSIS REPORTED March 21, 1986

LAB. NO. - 79608-5

MATERIAL Santa Fe Energy/Silver Thread Lease
Sampled: 3/5/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%		MILLIGRAMS PER LITER
Calcium (Ca)	5	100	1.0	Boron	119
Magnesium (Mg)	5	63	1.0	Fluoride	
Sodium (Na)	461	10600	96.6	Iron	1.7
Potassium (K)	6	220	1.3	Manganese	0.14
Carbonate (CO_3)	None detected			MBAS	
Bicarbonate (HCO_3)	198	12078	41.2	Copper	
Chloride (Cl)	282	10000	58.7	Zinc	
Sulphate (SO_4)	None detected			Arsenic	
Nitrate (NO_3)				Barium	19
Nitrate-N (NO_3-N)				Cadmium	
Total Hardness (as $CaCO_3$)		500		Chromium	
				Lead	
				Mercury	
				Selenium	
				Silver	
Total Dissolved Solids	1. Summation	33061		2. Residue @ 180°	

pH 7.9

EC X 10^{-6} at 25° C 34080

SAR

These results were obtained by following standard laboratory procedures: the liability of the corporation shall not exceed the amount paid for this report

Chemist

Ming Y. Wang

Fruit Growers Laboratory, Inc.

P. O. BOX 272 — 853 CORPORATION STREET — PHONE (805) 525-3824
659-0910

WATER ANALYSIS REPORT

OWNER -- JMT Oil Company

DATE SUBMITTED March 10, 1986

SAMPLER --

ANALYSIS REPORTED -- March 21, 1986

LAB. NO. -- 79608-4

MATERIAL Petro Mineral Corp./McGillivrae Lease
Sampled: 3/5/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%		MILLIGRAMS PER LITER
Calcium (Ca)	6	120	2.4	Boron	99
Magnesium (Mg)	4	54	1.6	Fluoride	
Sodium (Na)	239	5500	95.6	Iron	0.3
Potassium (K)	1	40	0.4	Manganese	0.10
Carbonate (CO_3)	None detected			MBAS	
Bicarbonate (HCO_3)	10	610	3.9	Copper	
Chloride (Cl)	248	8800	96.1	Zinc	
Sulphate (SO_4)	None detected			Arsenic	
Nitrate (NO_3)				Barium	1.2
Nitrate-N (NO_3-N)				Cadmium	
Total Hardness as $CaCO_3$		500		Chromium	
				Lead	
				Mercury	
				Selenium	
				Silver	

Total Dissolved Solids 1. Summation 15124 2. Residue @ 180°

pH 7.6
EC X 10^{-6} @ 25° C 21300
SAR

These results were obtained by following standard laboratory procedures. The liability of the corporation shall not exceed the amount paid for this report.

Chemist

Ming Y. Wang

Fruit Growers Laboratory, Inc.

P. O. BOX 272 · 853 CORPORATION STREET · PHONE (805) 525-0824
659-0910

WATER ANALYSIS REPORT

OWNER – JMT Oil Company

DATE SUBMITTED March 10, 1986

SAMPLER –

ANALYSIS REPORTED – March 21, 1986

LAB. NO. – 79608-3

MATERIAL Cities Source/Ventura Realty Lease
Sampled: 3/6/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%		MILLIGRAMS PER LITER
Calcium (Ca)	257	5140	53.2	Boron	41
Magnesium (Mg)	None detected			Fluoride	
				Iron	66.7
Sodium (Na)	222	5100	46.0	Manganese	1.8
Potassium (K)	4	150	0.8	MBAS	
				Copper	
Carbonate (CO_3)	None detected			Zinc	
Bicarbonate (HCO_3)	10	610	2 1	Arsenic	
Chloride (Cl)	468	16600	97.9	Barium	3.7
				Cadmium	
Sulphate (SO_4)	None detected			Chromium	
Nitrate (NO_3)				Lead	
				Mercury	
Nitrate-N (NO_3-N)				Selenium	
Total Hardness (as $CaCO_3$)		12850		Silver	
Total Dissolved Solids	1. Summation	27600		2. Residue @ 180°	

pH 6.7
EC X 10^{-6} @ 25° C 37867
SAR

These results were obtained by following standard laboratory procedures the liability of the corporation shall not exceed the amount paid for this report

Chemist

Ming Y. Wang

Fruit Growers Laboratory, Inc.

P. O. BOX 272 – 853 CORPORATION STREET – PHONE (805) 525-3824
659-0910

WATER ANALYSIS REPORT

OWNER -- JMT Oil Company

DATE SUBMITTED · March 10, 1986

SAMPLER --

ANALYSIS REPORTED – March 21, 1986

LAB. NO. -- 79608-2

MATERIAL Santa Fe Minerals S-14
Sampled: 3/6/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%		MILLIGRAMS PER LITER
Calcium (Ca)	5	100	2.5	Boron	84
Magnesium (Mg)	1	15	0.5	Fluoride	
				Iron	0.1
Sodium (Na)	196	4500	96.1	Manganese	0.19
Potassium (K)	2	80	1.0	MBAS	
Carbonate (CO_3)	None detected			Copper	
				Zinc	
Bicarbonate (HCO_3)	50	3050	24.8	Arsenic	
Chloride (Cl)	152	5400	75.2	Barium	1.2
				Cadmium	
Sulphate (SO_4)	None detected			Chromium	
Nitrate (NO_3)				Lead	
				Mercury	
Nitrate-N (NO_3-N)				Selenium	
Total Hardness (as $CaCO_3$)		300		Silver	
Total Dissolved Solids	1. Summation	13145		2. Residue @ 180°	

pH 7.8
EC X 10^{-6} @ 25° C 17937
SAR

These results were obtained by following standard laboratory procedures: the liability of the corporation shall not exceed the amount paid for this report.

Chemist

Ming Y. Wang

Fruit Growers Laboratory Inc.

P. O. BOX 272 · 853 CORPORATION STREET · PHONE (805) 525-3824
659-0910

WATER ANALYSIS REPORT

OWNER JMT Oil Company

DATE SUBMITTED March 10, 1986

SAMPLER –

ANALYSIS REPORTED March 21, 1986

LAB. NO. 79608-1

MATERIAL So. Calif. Gas Co., Rye Canyon
Sampled: 3/5/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%
Calcium (Ca)	55	1100	13.2
Magnesium (Mg)	7	90	1.7
Sodium (Na)	352	8100	84.2
Potassium (K)	4	150	1.0
Carbonate (CO_3)	None detected		
Bicarbonate (HCO_3)	44	2684	10.6
Chloride (Cl)	372	13200	89.4
Sulphate (SO_4)	None detected		
Nitrate (NO_3)			
Nitrate-N (NO_3-N)			
Total Hardness (as $CaCO_3$)		3100	

	MILLIGRAMS PER LITER
Boron	93
Fluoride	
Iron	5.6
Manganese	1.6
MBAS	
Copper	
Zinc	
Arsenic	
Barium	5.3
Cadmium	
Chromium	
Lead	
Mercury	
Selenium	
Silver	

Total Dissolved Solids 1. Summation 25324 2. Residue @ 180°

pH 6.3
EC X 10^{-6} @ 25° C 34080
SAR

These results were obtained by following standard laboratory procedures. the liability of the corporation shall not exceed the amount paid for this report.

Chemist

Ming Y. Wang

Frui^ Gro\. ...oj~, Inc.

P. O. BOX 27? - 853 CORPORATION STREE... PHONE (805) 525 3824
659-0910

WATER ANALYSIS REPORT

OWNER	JMT Oil Company	DATE SUBMITTED	March 10, 1986
SAMPLER --		ANALYSIS REPORTED --	March 21, 1986
LAB. NO. --	79608-10		

MATERIAL Wainoco Oil Company/Beverly Hills Lease
Sampled: 3/7/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%		MILLIGRAMS PER LITER
Calcium (Ca)	12	240	3.0	Boron	103
Magnesium (Mg)	6	71	1.5	Fluoride	
Sodium (Na)	378	8700	94.5	Iron	1.3
Potassium (K)	4	140	1.0	Manganese	0.14
Carbonate (CO_3)	None detected			MBAS	
Bicarbonate (HCO_3)	97	5917	23.8	Copper	
Chloride (Cl)	310	11000	76.2	Zinc	
Sulphate (SO_4)	None detected			Arsenic	
Nitrate (NO_3)				Barium	34
Nitrate-N (NO_3-N)				Cadmium	
Total Hardness (as $CaCO_3$)		900		Chromium	
				Lead	
				Mercury	
				Selenium	
				Silver	
Total Dissolved Solids	1. Summation	26068		2. Residue @ 180°	

pH 7.6
EC X 10^{-6} @ 25° C 30982
SAR

These results were obtained by following standard laboratory procedures: the liability of the corporation shall not exceed the amount paid for this report.

Chemist

Ming Y. Wang

Fru[illegible] Growers Laborato[illegible], Inc.

P. O. BOX 272 — 853 CORPORATION STREET — PHONE (805) 525-3824
659-0910

WATER ANALYSIS REPORT

EXHIBIT "G"

OWNER - JMT Oil Company

DATE SUBMITTED - March 10, 1986

SAMPLER --

ANALYSIS REPORTED -- March 21, 1986

LAB. NO. -- 79608-9

MATERIAL Petro Mineral Corp./Sadd Lease
Sampled: 3/5/86

	MILLIGRAM EQUIVALENTS PER LITER	MILLIGRAMS PER LITER	%		MILLIGRAMS PER LITER
Calcium (Ca)	4	80	2.0	Boron	71
Magnesium (Mg)	4	49	2.0	Fluoride	
				Iron	0.3
Sodium (Na)	191	4400	95.5	Manganese	0.09
Potassium (K)	1	30	0.5	MBAS	
				Copper	
Carbonate (CO_3)	None detected			Zinc	
Bicarbonate (HCO_3)	11	671	5.4	Arsenic	
Chloride (Cl)	192	6800	94.6	Barium	0.9
				Cadmium	
Sulphate (SO_4)	None detected			Chromium	
Nitrate (NO_3)				Lead	
				Mercury	
Nitrate-N (NO_3-N)				Selenium	
Total Hardness (as $CaCO_3$)		400		Silver	

Total Dissolved Solids	1. Summation	12030	2. Residue @ 180°

pH 8.3

EC X 10^{6} @ 25° C 18522

SAR

These results were obtained by following standard laboratory procedures: the liability of the corporation shall not exceed the amount paid for this report.

Chemist

Ming Y. Wang

MTS MITCHELL-TAYLOR & SONS
STIMULATION DIVISION

INVOICE

EXHIBIT "E"

(805) 589-5804

No. of Units & Container Type	HM	DESCRIPTION AND CLASSIFICATION (Proper Shipping Name and Class per 49 CFR 172.101)	TOTAL QUANTITY (Volume Gallons, etc.)	GROSS WEIGHT	PRODUCT CODE	PER.	NO. OF UNITS	UNIT PRICE	AMOUNT
1500 gal		15% HCL							
7 gal.		AI-25							
8 gal.		SS-20							
500 gal.		HAS.							
5 gal.		CORROSIVE LIQUID, N. O. S., Corrosive Material SS-20							
									2080.14
		Trucking							1000.00
		FLAMMABLE LIQUID, N. O. S.							

ORDER NO. ______ DATE 1-22-86

SOLD TO: J.M.T. Oil Co CUST. NO: ______

ADDRESS Placerita Cyn WELL NAME AND NO. Fee 11

FOR ACCOUNTING USE ONLY

DELIVERED BY (TRUCKER) ______

MTS SALESMAN ______ NO. ______

FROM WAREHOUSE ______ W/H NO. ______ F.O.B. ______

SUB TOTAL	
STATE TAX	
DRAYAGE	
OTHER TAX	
TOTAL ➡	3080.14

ORDERED BY ______ RECEIVED BY ______

REMIT TO : 1401 CALLA HERMOSA BAKERSFIELD, CA. 93309

PER* 4. GAL. 5. LB. 6. EA.

EXHIBIT "F"

WEST COAST ANALYTICAL SERVICE, INC.

...AL CHEMISTS

JMP Oil Co.
Job no. 2724
March 20, 1986

LABORATORY REPORT

	Relative % *
C5-15 aliphatic hydrocarbons	52
C16-25 aliphatic hydrocarbons	36
Naphthalene	0.7
Methylnaphthalenes	1.1
Dimethylnaphthalenes	1.5
Trimethylnaphthalenes	1.8
Toluene	0.1
Ethylbenzene	0.1
Xylenes	0.6
C9-10 alkylbenzenes	5.3

* - Percentage of total organic compounds detected.

DIVISION OF OIL AND GAS
RECEIVED
MAY 9 1986
VENTURA, CALIFORNIA

STATE OF CALIFORNIA-RESOURCES AGENCY

GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF CONSERVATION
DIVISION OF OIL AND GAS
6401 TELEPHONE ROAD, SUITE 240
VENTURA, CALIFORNIA 93003-4458
(805) 654-4761

August 5, 1986

Mr. Dan Murray, Agent
J.M.T. Oil Company
P.O. Box 819
Newhall, CA 91321

Re: PLACERITA FIELD,
WATER DISPOSAL AND
WATERFLOOD PROJECTS

Dear Mr. Murray:

An inspection of your water disposal and waterflood facilities in Placerita field was conducted on July 31, 1986. Several deficiencies that were observed during this inspection are in violation of the project approval permits. These deficiencies shall be corrected and prevented from reoccurring by August 15, 1986 or permits to inject will be revoked and/or a civil penalty imposed.

The following is a list of the observed deficiencies:

1. Water Disposal well "Thompson" W-1:

   a. Surface injection pressure higher than the approved pressure of 350 psi. Observed surface injection pressure was ~~1175~~ psi. -1175-

   b. Fluid that backflowed from well and flowed off the site and down the ravine shall be cleaned-up and hauled away to a suitable disposal facility.

   c. Wrong sign identifying the well as "Thompson" 2. OK

2. Water Disposal tank farm not properly bermed.

3. Water Disposal distribution pump:

   a. Class V fluid allowed to comingle with waterflood water.

   b. Fluid allowed to drain onto the ground prior to entering small below-surface tank.

   c. No guard on pump.

4. Waterflood receiving facility:

   a. Not adequately fenced off. The entire facility shall be fenced off to prevent unauthorized trucks from entering. NO

   b. Injection pumps leaking.

5. Waterflood tank farm and distribution pumps:

   a. Pump leaking. OK

   b. Tank leaking to the ground. — Tank empty - to repair

   c. Oil and water allowed to flow from tank and onto the ground, across the site and collect in an unauthorized earthen sump. This sump shall be evacuated and properly cleaned out and backfilled with dirt. Contact a Division engineer to witness operations. OK

6. Waterflood injection wells shall all be equipped with recently calibrated tubing gauges and the casing valve shall be equipped to install a test gauge.

Upon correction of these deficiencies, contact Pam Ceccarelli to arrange for reinspection.

Sincerely,

Murray W. Dosch

Murray W. Dosch
District Deputy

MD:MS:b

cc: WQCB
LA Co.Sanitation District

State of California

THE RESOURCES AGENCY OF CALIFORNIA

Memorandum

To : Bob Reid

Date : June 11, 1987

Subject: Disposal Wells

From: Department of Conservation--Division of Oil & Gas
Ventura

JMT Oil Company currently is the only operator that has a disposal facility accepting produced water that is trucked to the site. "Thompson" W-1 is the disposal well and it is located in Sec 31, T4N, R15W. The attached sheet indicates where the water originates from.

Mike

Michael Stettner
Acting Deputy Supervisor

Attachment
MS:bb

JMT OIL COMPANY, INC.

June 5, 1985

County of Los Angeles
Department of Engineer-Facilities
Sanitation Division
550 S. Vermont Street
Los Angeles, CA 90020

Gentlemen:

During the first quarter of 1985 (January 1 through March 31), J.M.T. Oil, Inc., 1-793-7, Industrial Waste Disposal Permit #1728, disposed of approximately 557,863 barrels of wastewater by injection into disposal and waterflood wells Fee #3, #6, #11, Thompson #1, and Sindell Community #2.

From Newhall Refining Company, Inc., approximately 238,541 barrels were hauled.

The remainder of approximately 319,322 barrels of produced wastewater were from Texaco, Inc., Southern California Gas Company, Petrominerals Corporation, Chevron, U.S.A., Inc., McFarland Energy, Elmtree Oil Company, Inc., Tosco, EORC, Santa Fe Minerals, Mr. Art Grayson, Tapia Oil Company, City Service Oil Company, Robert Sprowles, Lyons Canyon Oil Company, Argo Petroleum, Nahama and Weagant Energy Company, and Quintana Petroleum.

Enclosed are copies of our monthly water reports of wastewater hauled by trucks to our disposal wells. This does not include J.M.T. Oil, Inc. produced wastewater.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 5th day of June, 1985.

Le Ann Wills
Production

enclosures

P.O. BOX 819 NEWHALL, CALIFORNIA 91321 (805) 259-8920

State of California

THE RESOURCES AGENCY OF CALIFORNIA

Memorandum

034-22730

To : Bob Reid, Sacramento

Date : Sept. 11, 1986

Subject: NEWHALL REFINERY CO.,INC.
SOURCE WASTE WATER

From : **Department of Conservation—Division of Oil and Gas**
Office: Ventura

In regard to our phone conversation concerning the above refinery I have the following information from Mr. Hans Mangold, President of Newhall Refinery Co., Inc.

The waste water being sent to J.M.T. Oil Co. for injection in their water disposal well "Thompson" WD1 is about 35% oil field brines and 65% refinery effluent. The effluent is a mixture of the following:

Steam heating
Steam stripping
Heating asphalt lines
Desalting crude oil
Cooling towers,condensate-used to cool down products

The volume of waste water sent to J.M.T. is 2500 barrels per day. The refinery handles about 18,000 barrels of crude per day. The crude oil comes from the San Joaquin Valley field and Elk Hill field. The analysis shows that the waste water contains benzene, ethyl benzene, toluene and xylenes which are products in making gasoline.

The inference of all the BTC analysis that we are submitting to you is that the water is non-hazardous, none of the constituents are above the allowable State limits.

It is my understanding that this material cannot be injected in Class V wells if it's not oil field related. Let me know as soon as possible, how the Division will classify this material.

Mr. Mangold states that the disposal of the waste water, in the present manner, is essential to the refinery operation.

I am sending you analyses of the waste water for the period June 25 thru Aug. 6.

Murray W. Dosch
District Deputy

orm B

"EXHIBIT "H"

JMT OIL COMPANY, INC.

DATE STARTED	CUSTOMER	LEASE	DATE STOPPED
03-1985	AGNEW OIL COMPANY	UPPER OJAI	07-1985
09-1985	COMMANDER OIL COMPANY	CASTIC	PRESENT
12-1981	PETROMINERALS CORP.	SADD, MCGILLIVRAE BURNS - CRIST	PRESENT
06-1985	SANTA FE ENERGY	SILVERTHREAD	PRESENT
12-1984	NAHAMA WEAGENT ENERGY	DEL VALLE	PRESENT
05-1983	SANTA FE MINERALS	SESPE	PRESENT
04-1985	ELMTREE OIL CO.	ROGERS	PRESENT
12-1981	CHEVRON U.S.A.	USL, DEL ALISO	05-1986
01-1983	CITIES SERVICE	VENTURA REALTY	PRESENT
12-1981	MC FARLAND ENERGY	PITTS, BLACK	PRESENT
11-1985	WAINOCO OIL CO.	BEVERLY HILLS	PRESENT
11-1985	SHELL OIL CO.	MATINEZ CANYON	PRESENT
01-1986	OJAI OIL CO.	UPPER OJAI	PRESENT
09-1985	TERMO OIL CO. OF TEXAS	BERMITE	PRESENT
11-1981	NEWHALL REFINING	NEWHALL	PRESENT
01-1982	ART GRAYSON	NEWHALL	PRESENT
02-1984	TAPIA OIL CO.	DODGE-KAYE	PRESENT
08-1982	HART EXPLORATION	DEL VALLE	PRESENT
04-1985	VENTURA WEST INC.	OFFSHORE SANTA MARIA BASIN	PRESENT
01-1983	SHELL OIL CO.	DEL ALISO	PRESENT
11-1985	LEACH OIL CO.	COMPTON	PRESENT
11-1985	GEORGE LEACLER	HASLEY CANYON	PRESENT
11-1981	QUINTANA PETROLEUM	DEL VALLE	PRESENT
11-1983	TEXACO OIL CO.	TU, NORCOP, NORCOP B	01-1986
12-1981	GRACE PETROLEUM	PLACERITA CYN.	10-1983
06-1982	TOSCO E.O.R.C.	PLACERITA CYN.	PRESENT
05-1983	G.W.F. POWER SYSTEMS	PLACERITA CYN.	PRESENT
10-1982	SOUTHERN CALIF. GAS CO.	RYE CANYON	PRESENT

P.O. BOX 819 NEWHALL, CALIFORNIA 91321 (805) 259-8920

SOIL - WATER - PLANT ANALYSIS
AVOCADO and CITRUS CULTURE

ZINN SOIL LABORATORIES

1211 SOUTH FULLERTON ROAD
LA HABRA • CALIFORNIA
LAmbert 5-4626

Rothschild Oil Company

September 24, 1956

Report on Water Analysis

Marked - Thompson #1 Well

Laboratory No. 56-9-71

pH	11.2
	Parts per Million
Conductivity ($ECx10^6$ @ 25°C)	6250
Calcium (Ca)	712
Magnesium (Mg)	nil
Sodium (Na)	1730
Potassium (K)	50.
Boron (B)	4.5
Carbonates (CO_3)	54
Hydroxyl (OH)	285
Bicarbonates (HCO_3)	nil
Sulphates (SO_4)	195
Chlorides (Cl)	3210
NaCl (equivalent)	4400

FGL ENVIRONMENTAL

ANALYTICAL CHEMISTS

April 3, 1986
Lab. No. 79890

EXHIBIT "I"

JMT Oil Company
P. O. Box 819
Newhall, Calif. 91321

Gentlemen:

RE: WATER ANALYSES

Presenting the results of analyses performed on your seven (7) water samples received April 2, 1986. The samples have been described, as received, along with the data.

DATA

	Oil & Grease, mg/l
#1 Newhall Refining Co. Waste Water, 4/2/86	5
#2 Nahama Weagant Energy Corp. Del Valle Lease, N.L. & F. 3/13/86	3
#3 McFarland Energy, Black Lease, 3/17/86	16
#4 Termo Oil & Gas of Texas, Bermite Lease, 3/15/86	122
#5 McFarland Energy, Pitts Lease, 3/11/86	24
#6 Ojai Oil Co., Upper Ojai 4/1/86	110
#7 Quintana Pet. Corp. Del Valle, N.L. & F. Lease 3/12/86	119

If there are questions, please call.

Very truly yours,
FRUIT GROWERS LABORATORY, INC.

Ming Y. Wang

MYW:jl

APPENDIX G

GROUNDWATER MODELING CALCULATIONS

FOR SAUGUS AQUIFER

AT THE BERMITE FACILITY

APPENDIX G

INTRODUCTION

A number of hydrogeologic studies have been conducted at the 317 Area of the Bermite facility. The past studies used analytical methods based on the theories of two-dimensional groundwater flow, which are commonly used in groundwater flow analysis. In two-dimensional analysis, a fixed aquifer thickness is assumed and vertical flow components are neglected. At the Bermite site, however, such assumptions are problematic due to the massive thickness of the Saugus aquifer. The thickness of the Saugus aquifer could be greater than 1000 feet beneath the site. As a result of this thickness, the magnitudes of pumping influences at the site in the vertical and horizontal directions are similar. A three-dimensional analysis would include the vertical and horizontal effects of the pumping at the site, and is therefore preferable to a two-dimensional analysis.

An additional limitation on two-dimensional analysis is that the current pumping rate of the recovery well, MW-4, is fifty-seven times smaller than the pumpage used in the aquifer pump test. Because the present pumpage is so much smaller than in the pump test, an equivalent aquifer thickness (the vertical influence of the pumping well) used in two-dimensional analyses of the site for the two cases would be significantly different. For such differing aquifer thicknesses, the capture zones calculated in the two scenarios could inherently include large errors. A three-dimensional analysis is inevitably needed to provide useful answers to the site hydrogeology and pumping conditions. Three-dimensional analysis would eliminate the need for including any estimation of the equivalent aquifer thickness or vertical pumping influence.

The objective of this Appendix is to use methods based on analytic solutions to three-dimensional groundwater flow conditions to analyze the hydrogeology in this area. The solutions will provide answers as to the permeability and current pumping capture zone at the Bermite site.

THREE-DIMENSIONAL WELL IN UNIFORM FLOW FIELD

Simple, two-dimensional steady-state solutions of groundwater flow are commonly covered in the literature. Three-dimensional solutions to groundwater flow are less common in the literature. Three-dimensional solutions under time-changing conditions are even less frequently found.

A relatively simple solution is available in Strack (1988) that closely simulates the flow conditions at this site. The steady-state solution models a well as a point sink in three-dimensional space in which there is a uniformly-flowing field of horizontal background flow. The solution effectively simulates the site conditions found both prior to and after the installation of the recovery well system at MW-4. A uniform background flow was historically identified prior to the recovery well pumpage. Also, the three dimensional well can effectively simulate the flow rates now being introduced in the aquifer at MW-4.

In a form slightly modified from Strack (to eliminate the complexity of a potential function), the head, h, due to the three-dimensional well in uniform flow is expressed:

$$h = -i\,x - \frac{Q}{4\,\prod\,k\,r} + h_o \tag{1}$$

where h is the piezometric head at a location $r = (x^2 + y^2 + z^2)^{.5}$; i is the gradient of the uniform background flow in the direction of the x-axis (horizontal flow); Q is the discharge of the well located at r = O; k is the hydraulic conductivity; and h_o is the head at some large distance R_o from the well along the x-axis. The revised equation above includes all terms introduced by Strack.

This formula physically represents a well with a discharge Q capturing a cylindrical tube of uniform flow from upgradient. The flow conditions are shown in Figure G1. The radius of the tube gradually expands to a radius R far upgradient from the well. Using continuity of flow at such a point far upgradient, the following formula holds:

$$R^2 \prod k\, i = Q \qquad (2)$$

By solution, a point of stagnation is located at a distance one-half R downgradient from the pumping well. The radius of the capture tube at the well is about 0.7R.

For use in the analysis of the site hydrogeology, Equation (1) can be rearranged as:

$$k = \frac{Q}{4 \prod r\, (ho - h - i\, x)} \qquad (3)$$

All terms on the right side of this equation can be obtained from the analysis of a pumping test.

In the case at hand the wells involved are screened very close to the impermeable upper boundary of the aquifer, so it is appropriate to use image well theory. By this theory, the flow-field is calculated as through a second well (the image well) existed directly above the real well, the same distance above the aquifer's upper boundary as the real well is below the boundary, and with the same discharge. However, the well screen elevation in the present case is between 0 and 50 feet below the upper boundary. In light of the aquifer's great thickness, therefore, the well can be viewed as a point sink located "at" the upper boundary. The method of images in this case amounts to simply doubling the well discharge Q in Equations (1) - (3). The form of the "capture tube" in the aquifer is then exactly that of the lower half of the capture tube illustrated in Figure G-1. The tube's top half represents the hypothetical flow capture by the image well.

PUMPING TEST AND AQUIFER CHARACTERISTICS

In the pumping test conducted on June 7, 1989, well PW-1 was pumped for 300 minutes. From the pumping test data, Figure G-2 is a plot of draw-down versus time at well MW-4 at a distance 76 feet away. Although steady-state conditions were not achieved during the pump test, the trend in Figure G-2 suggests that draw-down at MW-4 would stabilize at about 20 feet. This value will be used to approximate the steady-state condition in the three-dimensional analysis (that is, h_o - h = 20 feet).

The background uniform flow has been fairly consistent over time both in its direction and gradient. Figure G-3 shows the groundwater contours on January 24, 1990. The gradient is about 0.2 percent (or i = 0.002) and the direction is west-northwest.

The direct distance between the pumping well PW-1 and the monitoring well MW-4 is 76.4 feet (r = 76.4 feet). MW-4 is located 73.4 feet downgradient (x = -723.4 feet) from PW-1 in the uniform flow direction as indicated in Figure G-3.

The pumping rate during the pumping test was 85 gallons per minute ($Q = 16{,}360\ ft^3/day$). The method of images applied in this case amounts to a simple doubling of the well discharge Q.

By applying all of the above factors to Equation (3) and replacing Q with 2Q to account for the image well, the resulting permeability is:

$$k = \frac{2Q}{4 \prod r\,(ho - h - i\,x)} = \frac{2(16{,}360)}{4{*}3.14{*}76.4(20{-}0.002{*}73.4)} = 1.72\ \frac{ft}{day}$$

The permeability is applied to Equation (2) and the equation is rearranged to solve for R, again with 2Q in place of Q. R is obtained as:

$$\begin{aligned} R &= [2Q / (\prod k\ i)]^{0.5} \\ &= [2(16{,}360) / (3.14{*}1.72{*}0.002)]^{.5} = 1740 \text{ feet} \end{aligned} \qquad (4)$$

Such a large value for R indicates that the influence of the pumping test is indeed far greater than a two-dimensional analysis can reasonably simulate.

Using the permeability from above, the specific discharge, q, of the uniform background flow can be calculated by:

$$q = k\,i = 1.72 * 0.002 = 0.0034 \text{ feet/day or } 1.3 \text{ feet/year}$$

Assuming the porosity (n) of the aquifer is 0.25, the velocity (v) of the background groundwater flow is:

$$v = q / n = 1.26 / 0.25 = 5.0 \text{ feet per year}$$

CAPTURE ZONE UNDER THE CURRENT DISCHARGE RATE:

Currently, well MW-4 is pumping at 1.5 gallons per minute as a means of capturing contaminants near the well. To analyze the capture zone of the system, the above theory can be applied to the MW-4 pumping scheme. In this case Q = 289 cubic feet per day. Applying this to equation (4), the value for R is:

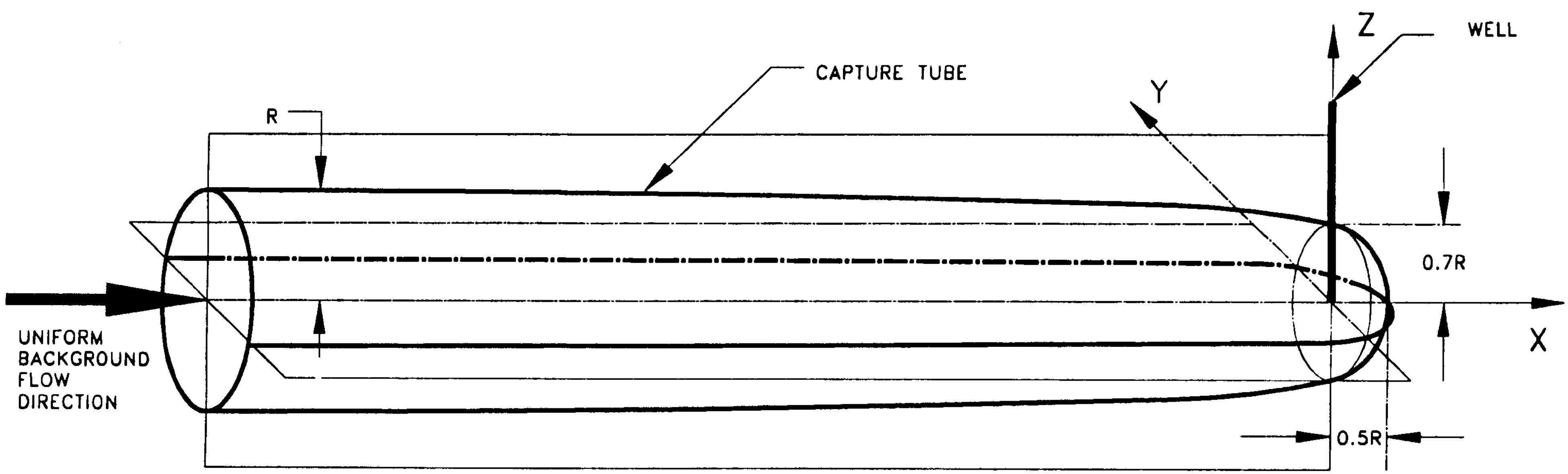
$$R = [2Q / (\prod k\,i)]^{.5} = 2(289) / (3.14*1.72*0.002)]^{.5} = 231 \text{ feet}$$

The stagnation point is located 0.5*231 = 115 feet downgradient of MW-4. The cross-gradient width of the capture zone at MW-4 is 2*0.7*231 = 323 feet. The capture zone depth there is half this, or 162 feet. Far upstream from MW-4, the width of the capture zone is 2*213=462 feet, and the depth is 231 feet. Figure G-3 shows the horizontal dimensions of this capture zone.

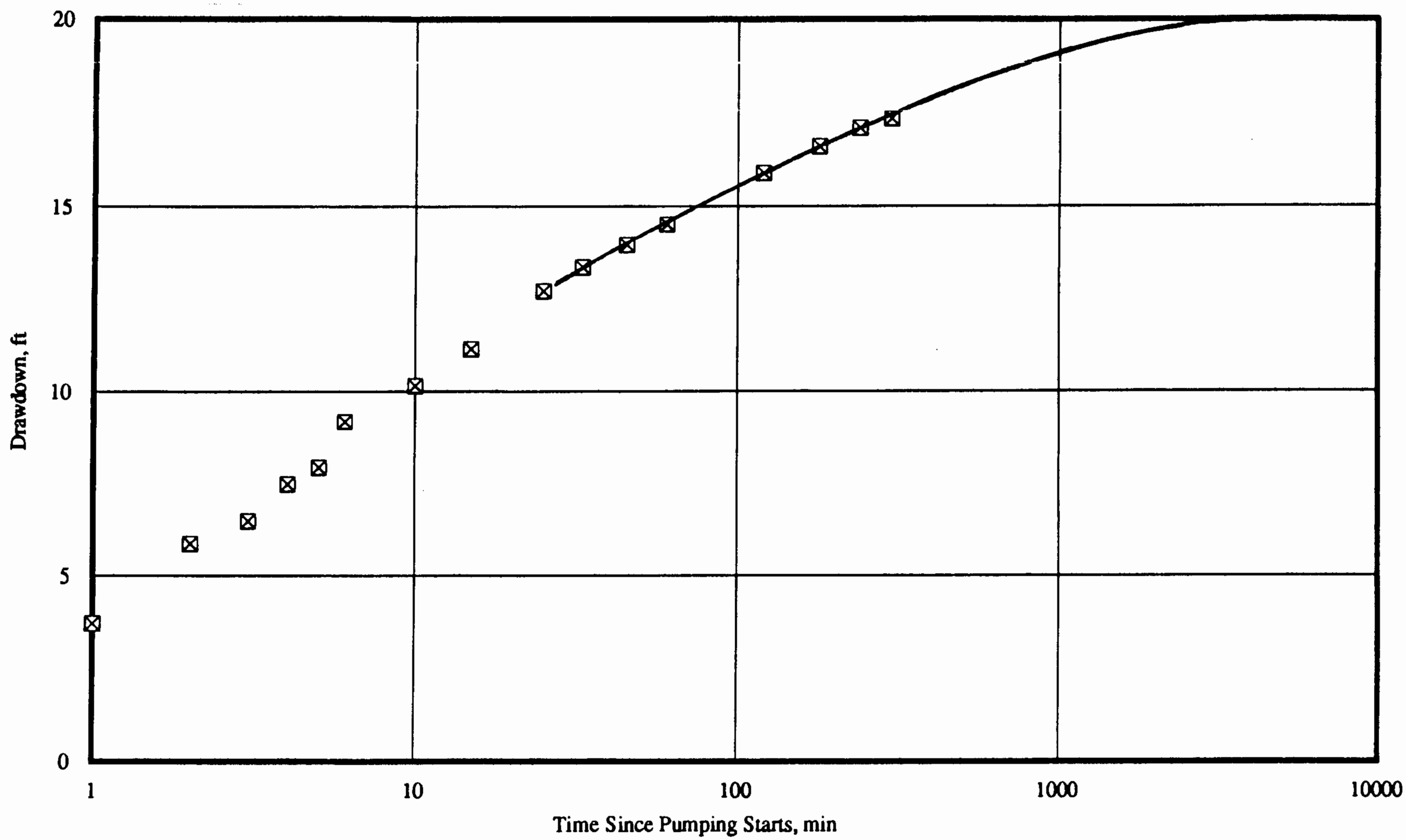
REFERENCE

Strack, O.D.L., 1989. Groundwater Mechanics. Prentice Hall, Englewood Cliffs, N.J.. pp. 215-218.

THREE DIMENSIONAL WELL IN UNIFORM FLOW FIELD

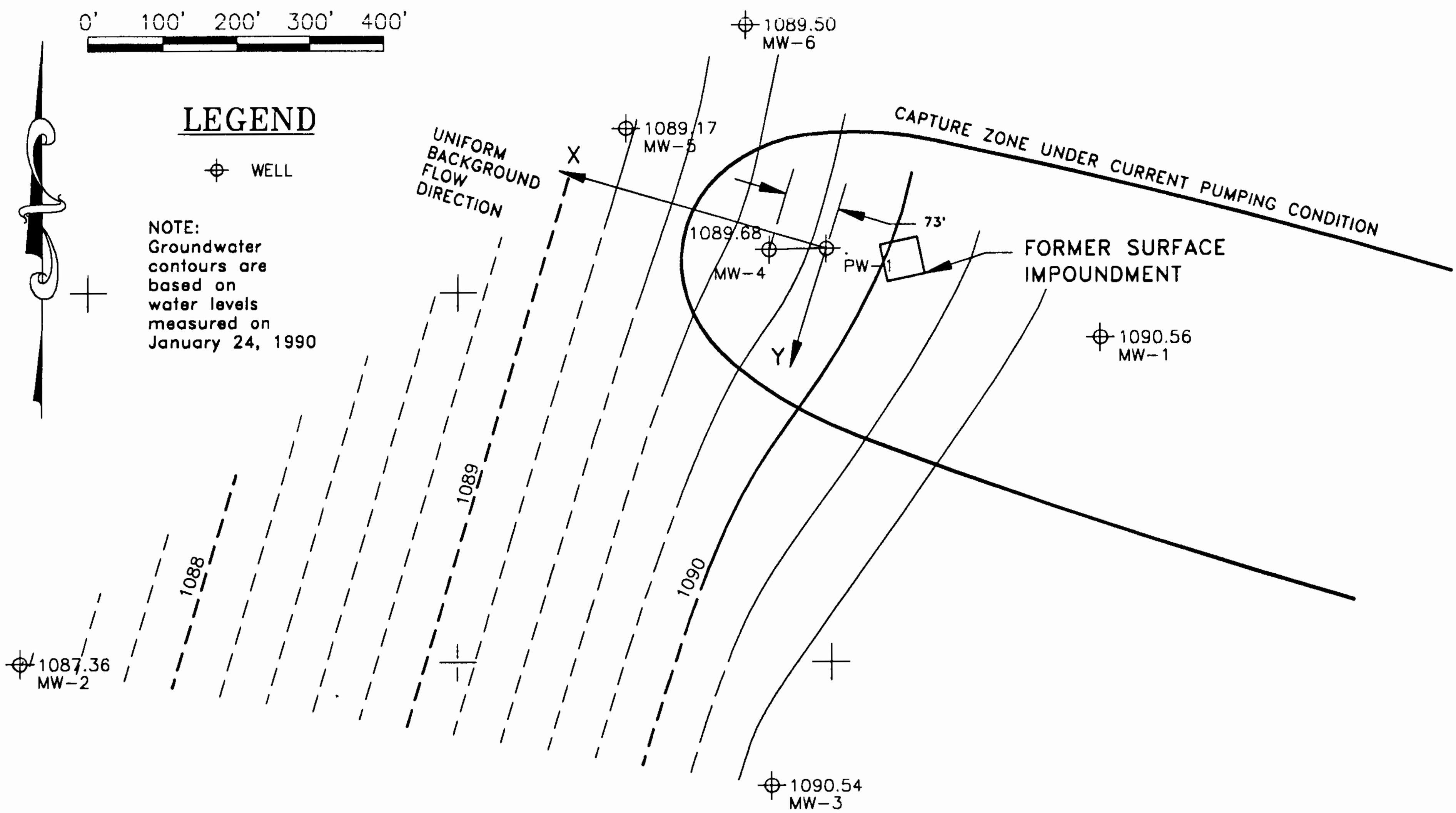


BERMITE DIVISION, WHITTAKER CORPRATION	WAI Consulting Engineers	MAY 1990
Three Dimensional Well in Uniform Flow Field	Wenck Associates, Inc. 1800 Pioneer Creek Dr. Maple Plain, MN 55359	G - 1



Pumping test conducted at PW-1, 76.4 ft away from MW-4; Pumping Rate: 85 gpm.
WENCK ASSOCIATES, INC.

BERMITE DIVISION, WHITTAKER CORPRATION	Wenck Associates, Inc. Consulting Engineers 1800 Pioneer Creek Dr. Maple Plain, MN 55359	MAY 1990
Pumping Test		G - 2



BERMITE DIVISION, WHITTAKER CORPRATION	WAI Consulting Engineers	MAY 1990
Plan View of Capture Zone, Q = 1.5 gpm from MW-4	Wenck Associates, Inc. 1800 Pioneer Creek Dr. Maple Plain, MN 55359	G - 3